No. 156408

State of Michigan
In the Supreme Court

PEOPLE OF THE STATE OF MICHIGAN,

Plaintiff-Appellant,

-vs-

KEVIN KAVANAUGH,

Defendant-Appellee.

ON APPEAL FROM THE COURT OF APPEALS
Court of Appeals No. 156408
Berrien Circuit Case No. 2014-00427-FH

CDAM'S AMICUS BRIEF

CRIMINAL DEFENSE ATTORNEYS
OF MICHIGAN

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Statement of Questions Involved

I. SHOULD A TRIAL JUDGE BE GIVEN DEFERENCE UNDER THE CLEAR ERROR WHERE THE EVIDENCE AT ISSUE IS WRITTEN OR NON-COURTROOM VIDEO?

The Court of Appeals answered, "No."
The Defendant-Appellee answers, "No."
This Amicus answers, "No."
The People answer, " Yes."
PAAM answers, "Yes."
As this is a question of appellate procedure, the trial court never addressed the issue.

Table of Authorities

Cases

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Secondary Sources

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Jurisdiction

CDAM believes this Court has jurisdiction to hear this dispute.

Statement of Facts

CDAM takes no position regarding the facts of this case. CDAM's interest is in adopting a fair standard of review for future cases where there is a digital record.

Argument

I. A TRIAL JUDGE IS GIVEN DEFERENCE UNDER THE CLEAR ERROR STANDARD BECAUSE HE/SHE HEARS LIVE TESTIMONY AND IS THE JUDGE OF DEMEANOR OR CREDIBILITY. IT IS ILLOGICAL TO EXTEND THIS DEFERENCE TO SITUATIONS WHERE THE TRIAL COURT LACKS THIS ADVANTAGE. WHERE THE EVIDENCE AT ISSUE IS WRITTEN OR NON-COURTROOM VIDEO, THE TRIAL COURT IS NOT ENTITLED TO DEFERENCE BECAUSE THE TRIAL COURT HAS NO SUPERIOR KNOWLEDGE OF THE FACTS.

Standard of Review. The question presented by amicus is a pure question of law about what standard of courts appellate courts should utilize when reviewing a video which was also reviewed by the trial court. This Court should decide this in the first instance.[1]

"Who are you going to believe? Me or your own eyes."[2]

This Court should recognize the advances in video recording technology are disruptive and find that it a video recording is worth more than a witness

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[1] *L-3 Communications Corp v OSI Sys, Inc*, 607 F3d 24, 27 (CA 2, 2010) (appellate procedure).

[2] 'Chico Marx,' Marx Brothers Duck Soup (1933) as quoted by Justice Breyer in Oral Arguments in Scott v Jeffers. Transcript of Oral Arguments, Scott v Harris, Supreme Court No. 05-1631, p. 54. The video excerpt from the Marx Brothers' Film is available at https://www.youtube.com/watch?v=qSabiG8q8-k.

account of events. The law should not remain stagnant as technology marches on. Thomas Jefferson once noted: "Laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths disclosed, and manners and opinions change with the change of circumstances, institutions must advance also, and keep pace with the times."[3] While Courts should not be on the cutting edge, they should not ignore the advances simply "because it has always been that way."[4]

While there is an understandable hesitance in embracing new technology, it should not result in paralysis. This Court should move forward with a measured response. Justice Scalia's opinion in *Scott v Harris* represents the recognition that the camera is not an ordinary witness in the room.[5] Where a

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[3] Letter Thomas Jefferson to Samuel Kercheval, July 12, 1816, original manuscript available on the Library of Congress website at https://www.loc.gov/resource/mtj1.049_0255_0262/ (last visited March 23, 2018). It is also reprinted on the Jefferson Memorial. https://www.monticello.org/site/jefferson/quotations-jefferson-memorial#footnote10_n1bj0rz (last visited March 23, 2018).

[4] Elizabeth G. Porter, *Taking Images Seriously*, 114 Colum. L. Rev. 1687 (2014) (noting that while courts have embraced courtroom technology, the "law has been trapped in a stylistic straitjacket"and proposing that 19th century rules of evidence should evolve to deal with the new technological advances).

[5] *Scott v Harris*, 550 US 372; 127 S Ct 1769, 1774–1776; 167 L Ed 2d 686 (2007) ("When opposing parties tell two different stories, one of which is blatantly contradicted by [a video], so that no reasonable jury could believe it, a

good quality video recording of the incident with a good chain of custody tells story "A," and a witness tells story "B," a Court should not treat two as equal. Where the trial court's alleged deference comes from his or her viewing or listening to a preserved source document,[6] the Court has no special knowledge to defer to.

Where there is a recording of the event in question that the trial court simply viewed (or in this case declined to view), an appellate court may review that recording and prefer it over the testimonial record below or the trial court's summary of what it viewed on the same recording. Where the event pertains to a recording of an event that happened in the courtroom and the trial court actually viewed the event (versus a recording of the event), this Court should

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court should not adopt that version of the facts for purposes of ruling on a motion for summary judgment.").

[6] For a discussion about whether *in courtroom* recordings should alter the standard of appellate review, *see* Robert C. Owen & Melissa Mather, *Thawing Out the "Cold Record": Some Thoughts on How Videotaped Records May Affect Traditional Standards of Deference on Direct and Collateral Review*, 2 J. App. Prac. & Process 411, 412 (2000); Mimi Samuel, Focus on Batson: Let the Cameras Roll, 74 Brook. L. Rev. 95, 114-15 (2008); Adele Hedges & Robert Higgason, *Videotaped Statements of Facts on Appeal: Parent of the Thirteenth Juror?, Hous. Law., July/Aug. 1995, at 24, 25; Bernadette Mary Donov*an, *Deference in a Digital Age: The Video Record and Appellate Review*, 96 Va L Rev 643, 675 (2010).

defer to the trial court's superior ability to see the event. For example, a question of witness demeanor should rarely be upset based on a recording. Just as most professional sports have adopted instant replay rules, appellate courts should be allowed to review the recording and make an independent call based on their viewing of the events.

Not only is the view presented by the PAAM short-sighted, but the forced construction offered by PAAM is contrary to the textualist philosophy normally seen in their briefs. They advocate that this Court rewrite a Michigan court rule to adopt an amendment to its federal counterpart which this Court never adopted. Further, it goes without saying that 1985 was before the digital revolution; police squad car and body cameras had not yet taken hold.[7] As more and more buildings have security footage, squad cars have cameras, and police officer's wear body cameras, the world has seen far more which has had a dramatic impact or as one writer has called it – "a paradigm shift."[8] A camera is

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[7] See "Digital Revolution," Wikepedia, available at https://en.wikipedia.org/wiki/Digital_Revolution (last visited March 23, 2018). The article speaks of the first digital camera being invented in 1988, the first public high definition broadcast was the 1990 World Cup, and that less than 1% of the world's information was stored in digital format in the late 1980s.

[8] Marielle A. Moore, *The Next State of Police Accountability: Launching a Police Body-Word Camera Program in Washington DC*, 14 Seattle J for Soc Just 145 (2015).

not just a witness, it is a first hand glimpse into what transpired. While cameras are not perfect,[9] a camera's memories don't grow worse over the passage of time, they do not suffer from cognitive biases, they are not influenced by suggestive investigative techniques, and they don't face internal review boards or the lengthy prison sentences for truthfully disclosing what they have seen.

In *Scott v. Harris,* the Supreme Court explicitly relied on a videotape of the events at issue where there were no allegations that the videotape had been doctored or altered.[10] *Scott*'s importance comes as much from the relatively minor changes that came from the Court's articulation of the summary judgment standard as the questions the Court itself was asking at trial.[11]

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[9] *Id.* at 147 (noting problems with cameras, but also noting that many of the problems are due to operator errors); Howard M. Wasserman, *Moral Panics and Body Cameras*, 92 Wash UL Rev 831, 837 (2015) (arguing that body cameras, while a good idea, are not necessarily as effective as proponents believe). For a excellent discussion about how camera perspective can distort the viewer's impression, *see* Mary D. Fan, *Justice Visualized: Courts and the the Body Camera Revolution*, 50 UC Davis L Rev 897, 947 (2017) (noting, for example, that a viewer is far more likely to find a confession involuntary if the camera is trained on the officer than the suspect).

[10]*Mobley v Tarlini*, 641 F Supp 2d 430, 434 (ED Pa, 2009) ("We are happy to allow the videotape to speak for itself"). *See also Mobley*, 641 F Supp 2d at 434.

[11] While counsel regards *Scott* as a defining moment with respect to how video has changed the standard of review, there a number of precursor instances where the High Court has engaged in factfinding by watching allegedly obscene videos, reviewing *Brandeis* briefs, considering scientific journal articles, and more. *See, gen.* Leah A. Walker, Will *Video Kill the Trial Court's Star:*

When the trial Court is in no better position than the appellate court to make a determination, the appellate court should not be prohibited from viewing and using the video at issue.[12] Contrary to PAAM,[13] there is a textual commitment for this position. That commitment comes from the text of the second sentence of the rule:

> (C) Review of Findings by Trial Court. Findings of fact by the trial court may not be set aside unless clearly erroneous. *In the application of this principle, regard shall be given to the special opportunity of the trial court to judge the credibility of the witnesses who appeared before it.*

How 'Hot' Records Will Change the Appellate Process, 19 Alb LJ Sci & Tech 449, 481 (2009).

[12] As an old Sixth Circuit decision remarked:

> [T]here was 'no factual controversy and no challenge to the evidentiary findings of the court.' In such a situation, an appellate court 'remains free to draw the ultimate inferences and conclusions which evidentiary findings reasonably induce.

Cordovan Assoc, Inc v Dayton Rubber Co, 279 F2d 289, 291 (CA 6), cert gtd, judgment vacated sub nom. Dayton Rubber Co v Cordovan Assoc, Inc, 364 US 299; 81 S Ct 268; 5 L Ed 2d 90 (1960)

[13] Prosecuting Attorneys Association of Michigan.

The words "in the application of this principle" are direction to appellate courts to give construe this deference *with regard to* the "special opportunity of the trial court to judge credibility of the witnesses who appeared before it." It is the ability of the Court to judge demeanor that is at the heart of this rule.[14] This Court should not read these words as nugatory.[15]

Where these factors do not exist, the deference should not exist either. The evidence at issue was documentary evidence (a video recording) that did not come from the mouth of a witness before it. Further the integrity of the documentary evidence was not at issue.

Lastly, while CDAM is writing concerning the broader concern of what is the appropriate standard of deference which should be given to the trial court with respect to areas where he/she has no particular expertise, it needs to be mentioned that the Court chose not to review the video. Where the Court of Appeals is as capable of trial court to review the evidence in the first instance, it would be a waste of judicial resources for the appellate court to remand the matter to the trial court for it to review the written evidence and solely only for

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[14] Cf *United States v United Steelworkers of Am*, 271 F2d 676 (CA 3), aff'd 361 US 39; 80 S Ct 1; 4 L Ed 2d 12 (1959).

[15] "Whenever possible, every word of a statute should be given meaning. And no word should be treated as surplusage or made nugatory." *Apsey v Mem Hosp*, 477 Mich 120, 127; 730 NW2d 695, 699 (2007) (quoting *People v Warren*, 462 Mich 415, 429 n. 24; 615 NW2d 691 (2000)).

the appellate court to then review the trial court's comments on a video and determine whether they agreed.

A. The 1985 Changes to Fed. R. Civ. P. 52(a) Were Never Adopted in Michigan and Should Not be Adopted Through the "Back Door."

PAAM argues that the 1985 changes to Fed. R. Civ. P. 52(a) should be applied by analogy to this case.[16] Those changes now reads "findings of fact, whether based on oral or other evidence" must not be set aside. Those changes were adopted in 1985 --- just before the digital revolution. They were not copied in Michigan.

As was correctly noted by PAAM, prior to those amendments many federal courts stated that where the area was not in the particularly expertise of

[16] PAAM Brief, p. 5.

the trial court, this deference should not be granted.[17] As an old Sixth Circuit case noted:[18]

> There was no factual controversy and no challenge to the evidentiary findings of the court. The evidence consisted entirely of written instruments and other writings which a reviewing court is competent to interpret, and is not precluded from doing so by Rule 52 of the Federal Rules of Civil Procedure, 28 U.S.C.A. following section 723c. It remains free to draw the ultimate inferences and conclusions which evidentiary findings reasonably induce. *Reinstine v Rosenfield*, 111 F2d 892 (CA 7, 1940); Reinstine v. Rosenfield, 7 Cir., 111 F.2d 892. Indeed, it is the duty of the reviewing court to review the evidence in order to determine whether decision below was or was not clearly erroneous, and that duty becomes the more imperative where the trial court has had no occasion to observe witnesses or to judge of their credibility in arriving at a factual basis for decision.

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[17]*See, e.g. Fleming v Palmer*, 123 F2d 749 (CA 1, 1941) (noting that the District Court's finding of fact regarding witness testimony was entitled to deference, but the rule did not apply to the documentary evidence); *U S ex rel Brown v Smith*, 306 F2d 596 (CA 2, 1962) (no special deference to be granted to judge's factfinding based on reading transcripts of a related state case); United States v United Steelworkers of America 271 F2d 676 (CA 3 1959), affirmed 361 US 39, 4 L Ed 12, 80 S Ct 1 (noting that less deference was required when reviewing a trial court's factfinding which was based on written affidavits); *Charles Peckat Mfg. Co. v Jacobs*, 178 F2d 794 (CA 7 1949) (noting that appellate court was perfectly capable of reviewing prior patents concerning a subject matter).

[18] *Letcher Co, Ky v De Foe*, 151 F2d 987, 990 (CA 6, 1945).

It is not the Court of Appeals who made a non-textual amendment to it the rule is PAAM who is proposing just that.[19] Further, CDAM dispute that the even the current federal position is as clear as PAAM claims.[20]

Where Michigan adopts a statute from another jurisdiction, the accompanying interpretation is given significant deference.[21] This is not that situation. The situation at bar is that Michigan adopted the original rule, but not the later amendments to the rule. PAAM is trying to bootstrap that new rule into the Michigan system bypassing the very rulemaking procedures that it believes are essential.[22] In *Stellwagen*, the Court dealt with a New York statute succession

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[19] *Cf* PAAM Brief, p. 8.

[20] *See Ramirez v Martinez*, 716 F3d 369, 374 (CA 5, 2013) (evaluating the case under the decision of *Scott*, though distinguishing in the end because of factual differences); *People v Mack*, 190 Mich App 7, 17; 475 NW2d 830 (1991) (considering *Scott* the in court's decision but distinguishing *Scott* because of factual differences); *United States v Foreman*, 369 F3d 776, 789 (CA 4, 2004) (Gregory, J., dissenting) (recognizing court's reliance on video evidence instead of findings of the court in granting reversal); *Newkirk v Enzor*, No. 4:13-CV-01635-RMG, 2015 WL 3853167, at *7 (DSC, June 19, 2015), on reconsideration in part No. 4:13-CV-01635-RMG, 2015 WL 13595040 (DSC, July 28, 2015) (discussing *Scott*); *Hilliard v Com*, 43 Va App 659; 601 SE2d 652, 659 (2004), aff'd 270 Va 42; 613 SE2d 579 (2005) (per curiam).

[21] *Weaver v Rix*, 109 Mich 697, 698; 67 NW 970, 971 (1896); *Stellwagen v Durfee*, 130 Mich 166, 168; 89 NW 728, 729 (1902); *Preston Nat Bank v Brooke*, 142 Mich 272, 274; 105 NW 757, 758 (1905).

[22] Cf PAMM brief, p. 2-3 (text and footnote 1).

statute which we borrowed. By the time *Stellwagen* had reached this Court New York had legislatively altered their scheme, but the Court analyzed it under the New York pre-amendment case law. Similarly, this Court noted that this rule of construction was applicable . This Court noted:[23]

> The rule, however, can have no application in the instant case, because the statute under consideration did not receive judicial construction in Massachusetts until *long after* its adoption by this state. The decision in that state should receive just that consideration as authority to which it would be entitled under ordinary circumstances. Examined in this light, it is not convincing. The statute is not analyzed, and no reason or authority is advanced in support of the conclusion. It is a bald determination of the point at issue without more.

With all the criticisms of the Court of Appeals' approach, what PAAM fails to consider is the fact that their argument (if accepted) would delegate the interpretation of statute court rules to Federal Rules Committees which would be worse than delegating it to our courts.

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[23] *Goodell v Yezerski*, 170 Mich 578, 579–80; 136 NW 451, 452 (1912) (emphasis in the original).

People v Zahn, 234 Mich App 438, 445–446; 594 NW2d 120 (1999) relied on by the Court of Appeals correctly interprets our court rules as they are presently written. There, the Court noted:

> The deferential "clear error" standard is the appropriate standard of review for findings of fact because the trial court is usually in a superior position to assess the evidence. See People v. Mack, 190 Mich.App. 7, 17, 475 N.W.2d 830 (1991). In this case, however, the trial court made its decision solely on the basis of the preliminary examination transcript. Therefore, the trial court was in no better position than this Court to assess the evidence, and there is no reason to give special deference to the trial court's "findings."

As PAAM has correctly noted *Zahn* is not alone in constraining the deference contained in this provisions to cases where the trial court actually had a superior ability to consider these matters. The Court of Appeals has generally declined to afford this deference where the evidence is non-testimonial.[24] For these reasons, CDAM believes the appropriate standard should be the de novo standard of review.[25]

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[24] *People v White*, 294 Mich App 622; 823 NW2d 118 (2011), aff'd 493 Mich 187; 828 NW2d 329 (2013) (no deference to video regarding video disc of event which took place out of the courtroom); *Bunnell v State*, 292 Ga 253; 735 SE2d 281, 285 (2013); *City of E Grand Rapids v Vanderhart*, No. 329259, 2017 WL 1347646 (Mich Ct App, April 11, 2017), app den 501 Mich 927; 903 NW2d 579 (2017).

[25] *See Bunnell v. State*, 735 SE2d 281, 285 (Ga. 2013) (adopting de novo because controlling facts are obtainable by watching video); *People v Small*, No. 1-

Justice Kelly has similarly suggested that the rationale underlying deference to the trial court on a motion for new trial involving newly discovered evidence should not apply where the motion is heard by a successor judge who has taken no testimony:[26]

> [T]he rationale for a remand to the trial court rests in large part on the theory that the judge there has the benefit of having tried the case. The trial judge would normally have superior knowledge of the facts that were presented at trial. He or she would apply that knowledge to the question of whether a different result is probable on retrial were the newly discovered evidence to be admitted. But in this case,

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13-0190, 2014 IL App (1st) 130190-U, at *8 (Ill App Ct Dec 13, 2014) (the Illinois Supreme Court has noted"that where the evidence at trial consists solely of documentary evidence, the reviewing court is not bound by the trier of fact's findings and may review the evidence de novo." (citation omitted)), appeal denied, 32 NE3d 677 (Ill. 2015); *Com v Novo*, 442 Mass 262; 812 NE2d 1169, 1173 (2004) (finding that, where video evidence was the sole evidence relied upon by the trial court, independent review was appropriate because fact-finder was in no better position than appellate judges to determine contents and significance); *State v Rubek*, 7 Neb App 68; 578 NW2d 502, 507–08 (1998) (employing clearly erroneous standard but nonetheless relied on videotape almost exclusively in concluding the lower court erred); *State v Tuttle*, 650 NW2d 20, 35 (SD, 2002) (recognizing videotape indicated beyond doubt that detective's threat caused confession); *State v Gendron*, No. 08-13-00119-CR, 2015 WL 632215, at *6 (Tex App, February 11, 2015), (finding the trial court's determinations were entitled to deference unless the videotape indisputably contradicted those findings), petition for discretionary review filed (Mar. 18, 2015); *Hilliard v Commonwealth*, 601 SE2d 652, 659 (Va. Ct. App. 2004) (noting the tone of voice, inflections, and demeanor in coming to conclusions), aff'd, 613 SE2d 579, 585 (Va 2005) (noting appellate court exceeded scope by taking stock of demeanor although error was harmless).

[26] *People v Grissom*, 492 Mich 296, 322–23; 821 NW2d 50, 64 (2012) (Kelly, J. concurring)

> the trial judge has retired from the bench, and this Court's remand will go to a judge who in all likelihood knows nothing of the facts of this case.

Further, the Court may have had an "opportunity" in the abstract to view the recording, but the Court never availed itself of the opportunity. It is undisputed that the Court chose not to view the recording and simply confine its ruling to the testimonial record.

B. Adoption of a De Novo Video Replay Rule Will Best Preserve the Interest of 21st Century Justice and Will Enhance the Reputation of the Court in the Public Eye.

CDAM's position that *de novo* review of non-testimonial evidence will not necessarily favor the defense. It is probable that the new standard will be used as often to reverse favorable defense rulings as it will to reverse pro-prosecution rulings. What such a ruling will do is preserve the integrity of the judicial system. Recordings of these incidents are public record and will be shown on television and the internet. Judicial factfinding which is contrary to the video record will bring the judiciary in disrepute in just the same way that a bad umpire call will create a public outcry about public sports.

As the public is increasing exposed to videos of police/citizen encounters,[27] it is essential to preserve the public confidence in the Courts that

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[27] *See, e.g.* Laura Wamsely, "Video Shows Sacramento Police Shooting Unarmed Black Man In Grandparents' Backyard, NPR (March 22, 2018) available at https://www.npr.org/sections/thetwo-way/2018/03/22/596051907/video-

video recordings are given careful and probing consideration by the appellate courts. This consideration is more important the interest in finality of rulings

shows-sacramento-police-shoot-unarmed-black-man-in-grandparents-backyard (last visited March 23, 2018); Tim Barber, "Dash cam video released from U.S. Park Police shooting that killed Virginia man," ABC 7, (March 23, 2018) http://wjla.com/news/local/police-man-shot-and-killed-in-prince-georges-county (last visited March 23, 2018); Elena Ferrain, What Elgin police video shows: Woman shot as she leaves vehicle, knife in hand, Daily Herald (March 22, 2018) available at http://www.dailyherald.com/news/20180322/what-elgin-police-video-shows-woman-shot-as-she-leaves-vehicle-knife-in-hand (last visited March 23, 2018); Lilian Kim SF police investigate shootout that injured 6, including officer, ABC News7 (March 21, 2018) available at http://abc7news.com/sf-police-investigate-shootout-that-injured-6-including-officer/3244706/ (last visited March 23, 2018); Rod Decker, Board says video of controversial police shooting should be released, appeal expected, KUTV News March 21, 2018) available at http://kutv.com/news/local/board-says-video-of-controversial-police-shooting-should-be-released-appeal-expected (last visited March 23, 2018) O. Smith, Eyewitness captures video as man shot, killed in Flint-area police standoff, MLive (March 23, 2018) available at http://www.mlive.com/news/flint/index.ssf/2018/03/eyewitness_captures_video_as_m.html (last visited March 23, 2018).

Because of the exhaustive number of similar articles, counsel has deliberately limited the representative articles to videos released within the last before March 23, 2018 (the date of completion of the draft of this brief). The purpose of citing these stories is to demonstrate that security videos of police/citizen encounters are regularly becoming a part of the public record and that judicial factfindings which run contrary to the videos face increasing public scrutiny.

and judicial economy which underlies the contrary rule.[28] This Court should not check its common sense at the door.[29]

[28] The purpose underlying the contra rule was explained by the New Jersey Supreme Court as follows:

> First, our system of justice assigns to our trial courts the primary role of factfinder. That role is especially suited to our trial judges, who have ongoing experience and expertise in making factual rulings. Trial judges routinely make factual determinations not only in assessing the credibility of witnesses but also in assessing documentary evidence, which oftentimes is susceptible to alternative inferences.
>
> Second, the customary role of an appellate court is not to make factual findings but rather to decide whether those made by the trial court are supported by sufficient credible evidence in the record. That limited standard of review is consistent with the belief that appellate courts should not replicate the work of our trial courts or reverse their factfindings based on a mere difference of opinion.
>
> Third, notions of judicial economy and finality call for a standard of review where appellate courts defer to a trial court's factual findings in the absence of clear error.

State v SS, 229 NJ 360, 364–65; 162 A3d 1058, 1060 (2017).

[29]As the United States Supreme Court has remarked: "We do not leave our common sense at the doorstep when we interpret a statute"

Just as an umpire call which is directly contradicted by the instant replay video log may erode public confidence in the game, so too would be upholding judicial calls which are directly contradicted by the non-contradicted record. Ironically, these calls are more likely to favor the prosecution in the long run since the determination of probable cause focuses on reasonableness. An appellate court reviewing such a record is more likely to determine that an officer's actions are reasonable rather than unreasonable.[30] An appellate court reviewing the recording of a drunk driving suspect is more likely to see gaps in the performance of the field sobriety of test than to declare that the no reasonable person could have judged the driver's performance as substandard. Unfortunately, in their quest to win, the People have not considered the societal

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Price Waterhouse v Hopkins, 490 US 228; 109 S Ct 1775, 1786; 104 L Ed 2d 268 (1989).

[30] In *State v SS*, 229 NJ 360; 162 A3d 1058, 1059 (2017), relied on by PAAM, CDAM's New Jersey counterpart (the Association of Criminal Defense Lawyers of New Jersey) as amicus curiae argued for the clearly erroneous test urged by PAAM and the Berrien County Prosecutor's Office. 162 A3d at 1065. Similarly, the New Jersey ACLU as amicus argued that an appellate court should have only considered that defendant's words and not his tone of voice. 162 A3d at 1065. After significant contemplation CDAM has departed from traditional criminal defense viewpoint believing that the long societal goals of accuracy and public integrity favor the de novo standard. It therefore finds its position aligned with the New Jersey Attorney General's Office. Cf *SS*, 229 NJ 360, 373; 162 A3d 1058, 1065 (noting Attorney General's position).

term goal of the appellate process, viz. to insure the integrity and accuracy of the process rather than for a particular "team" to win.

C. *Not Giving Special Respect to Video Recordings to the Actual Incident at Issue Will Undermine the Public's Confidence in the Judiciary.*

There is no question that video recording can have problems. They can start too late, end too early, not capture the correct angles, can be deceptively edited, and can sometimes be poorly lit. Human memory, however, has even more problems. Evolving research is showing that the more times a witness repeats a story the more errors are innocent interjected into their recall.[31] Since the witnesses are not aware of these errors, witness demeanor may exude confidence even when they are in. Digital images do not have this degredation.

With proper safeguards, allowing appellate courts to substitute their opinion, is essential to the integrity of the law. When the New York Times has a article on the front page of the March 18th issue of the paper discussing police

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[31] *See* Donna Bridge and Joel Voss, *Active Retrieval Facilitates Across-Episode Binding by Modulating the Content of Memory*, 63 Nueropsychologia 154 (2014) (noting the errors in human memory and how every repetition of the facts of events leads to additional distortion); Donna J. Bridge and Ken A. Paller, *Neural Correlates of Reactivation and Retrieval-Induced Distortion,* 2012 J. of Nueroscience 12144 (2012) (same). Both of these articles appear in the Appendix, together with a plane English summary of the 2014 article from the Northwestern University School of Medicine's website.

lying in courts; it is easy to imagine a scenario where a video that contradicts testimony becomes public.[32] If this (imaginary) video has been ignored by appellate courts, the public perception of justice will rightfully be tainted.

When there is no tape, the testimony of the participants is the only way to proceed. However, when a tape exists, there is now a document that favors neither side; absent a showing that the tape was somehow edited or altered; this is by far the most accurate portrayal of what happened. Appellate Courts should be not prohibited from reviewing tapes and determining what occurred.

In the case at bar, the Court declined to review the tape at all and left no room for police misrepresentation. The Court of Appeals acted in properly in reviewing the video and drawing its own conclusion from the video.

D. Like Professional Sports, the Time Has Come to Adopt an "Instant Replay Rule." Appellate Courts Should Critically Examine Video Evidence and Not Simply Defer to Trial Court Factfindings.

Imagine for one moment watching a game deciding play on a major league sports game on a large screen high definition television. The referee calls the play one way, but your perception says something different. Now the

[32] J. Goldstein, Testilying'by Police:A Stubborn Problem Police Lying Persists, Even Amid An Explosion Of Videoevidence That Has Allowed The Public To Test Officers' Credibility, The New York Times (March 18, 2018) https://www.nytimes.com/2018/03/18/nyregion/testilying-police-perjury-new-york.html (last visited March 18, 2018).

television network's replays from four angles show that the referee's call was wrong. The league announces the referee's call good in fact be wrong, but the interest of finality dictate that the referee's call be wrong. For many years, this was the rule in sports, but as instant replay technology became higher resolution and more accessible, professional sports changed its position. Similarly, this Court must respect the change in technology which has occurred.[33]

The reliability of video evidence over person observational can be clearly seen in the existence of the instant replay in sports refereeing. This is not a new or trendy decision. The first major sport to use instant replay was United States football in 1986. Since that date it has expanded to include many more calls. Instant replay is also used in Canadian football, basketball, ice hockey, field hockey, tennis, fencing, rugby, cricket, rodeo. Even the notoriously conservative sport of baseball implemented instant replay in 2008 and greatly expanded it in 2014. The FIFA World Cup will use it in 2018.[34] Looking at all of the sports together, the clear message is that once it is use; it's use expands since it does

[33] Counsel is not the first to compare law with sports and judges with umpires. See Chad M. Oldfather & Matthew M. Fernholz, *Comparative Procedure on a Sunday Afternoon: Instant Replay in the NFL as a Process of Appellate Review*, 43 Ind L Rev 45 (2009) (collecting such comparisons).

[34] Wikipedia, Instant Replay, available at https://en.wikipedia.org/wiki/Instant_replay (last reviewed March 19, 2018).

provide evidence unobtainable in any other fashion. In general, limitations are more and more just those designed to keep the game moving and video replay is considered to be the best evidence.

Sports, which like law, puts great value on integrity, is put in a bad light when referees make calls that everyone can clearly see are incorrect. There are few in Michigan that will forget the blown call in 2010 that cost Armando Galarraga a perfect game. With Galarraga one out away from baseball history with the Tigers, Joyce called the Indians' Jason Donald safe at first base when replays showed he was clearly out. In 2010 baseball limited replays to only a few types of events; in 2018 the rule would have allowed the review and the perfect game would be on the record.

The time as come for the law to recognize that a video recording provides a superior record of what actually transpired than witness testimony. Where the trial court was also a passive reviewer of the video (e.g. not present when the incident at issue was actually recorded) an appellate court has the right and the duty to carefully review that video and not hesitate to overrule the trial judge/referee's "call" in the appropriate case.

Relief

CDAM requests this Court to affirm the Court of Appeals and reject the proposals to modify MCR 2.613.

Respectfully submitted,

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Dated March 26, 2018

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Proof of Service

STATE OF MICHIGAN)
) SS.
COUNTY OF OAKLAND)

The undersigned declarant being first duly sworn, deposes and says that on March 26,2018 (s)he did e-Serve a copy of the attached CDAM Amicus Brief to: Aaron J. Mead at the Berrien County Prosecutor's Office, Daniel Grow at his email address of record, and Timothy Baughman at the Wayne County Prosecutor's Office as Counsel for the Prosecuting Attorneys Association of Michigan.

Declaration in Lieu of Notarization. I declare that the foregoing is true and correct to the best of my information, knowledge, and belief.

Respectfully submitted,

/s/Stuart G. Friedman

Declarant

DATED: March 26, 2018

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APPENDIX A

Behavioral/Systems/Cognitive

Neural Correlates of Reactivation and Retrieval-Induced Distortion

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Reactivation of recently acquired information can strengthen memory storage and likely contributes to memory consolidation. Retrieval (generating information about prior events) may improve memory storage because it entails reactivation. Alternatively, retrieval may promote storage of retrieved information, and, if retrieval is inaccurate, subsequent recall could be distorted by the retrieved information. If retrieval modifies memory storage, as hypothesized, neural signals associated with accurate retrieval at that time may be distinct from neural signals associated with the degree of repeated retrieval error evident at some later time. We tested this prediction using a 3-session protocol. During session 1, people learned object-location associations to criterion and completed a cued-recall test in which locations were recalled upon viewing objects. During session 2, an electroencephalogram (EEG) was recorded during cued recall for a subset of the associations. During session 3, cued recall was tested for all associations. Retrieval improved storage, in that recall at session 3 was superior for objects tested in session 2 compared with those not tested. Retrieval-induced distortion was revealed in session 3 for those objects tested in session 2, in that those objects were generally placed closer to locations retrieved at session 2 relative to original study locations. EEG analyses revealed positive potentials (400–700 ms) associated with relatively accurate recall at session 2. Memory updating was reflected in positive potentials after 700 ms that differentially predicted the degree to which recall promoted storage of the session-2-retrieved location. These findings demonstrate unique neurocognitive processing whereby memories are updated with information produced during retrieval.

Introduction

Memory reactivation refers to neural activity corresponding to information previously learned (Wilson and McNaughton, 1994; O'Neill et al., 2010; Carr et al., 2011). Reactivation of recently acquired events may operate to strengthen associative links among cortical networks that specialize in processing and storing particular types of information. Reactivation could thus facilitate systems consolidation, the gradual process whereby newly acquired memories for facts and events become enduring (Alvarez and Squire, 1994; McClelland et al., 1995; Paller, 2009).

Does retrieval alter memory storage through a reactivation-related mechanism? Successful retrieval always entails reactivation to some degree, whereas reactivation need not entail conscious retrieval of information about a prior episode. Cueing procedures that engage retrieval produce lasting benefits (Landauer and Bjork, 1978; Karpicke and Roediger, 2008), but the neural mechanisms mediating these benefits are unknown.

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Author contributions: D.J.B. and K.A.P. designed research; D.J.B. performed research; D.J.B. and K.A.P. analyzed data; D.J.B. and K.A.P. wrote the paper.

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The authors declare no competing financial interests.

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Retrieval may be effective because it includes reactivation, but it may also enable memory storage to be updated with new information (Dudai and Eisenberg, 2004). During retrieval, environmental information in the current spatiotemporal context could become associated with stored information (Karlsson and Frank, 2009). Also, information retrieved in response to a cue could become integrated into stored memory representations.

Retrieval rarely provides a complete and precise account of prior events; rather, recall often includes both veridical and erroneous information. Therefore, if retrieval promotes storage of retrieved information, memories could come to include information learned during the original event and information activated via erroneous retrieval. This scenario could account for gradual memory distortion, or even mostly false recollection, after multiple recalling and retelling episodes.

Here we examined the degree to which retrieval facilitated veridical memory storage and the degree to which retrieval produced memory distortion in conjunction with errors in retrieval. We hypothesized that retrieval preferentially promotes storage of retrieved information instead of merely strengthening memory for the original event. Retrieval should thus have two distinct consequences. To the extent that correct information is recalled, retrieval will promote subsequent memory accuracy. Conversely, recalled information that diverges from the original event will be incorporated into the memory representation, thereby promoting memory distortion.

We examined the consequences of retrieval by testing object-location associations over multiple sessions. Each participant learned to associate objects with unique locations. Then, cued-recall tests provided fine-grained measures of the degree to which participants recalled the correct locations. Results from this test not only provided accuracy indices but also showed the degree to which recall was biased with respect to locations retrieved previously. In this way, we could determine whether retrieval preferentially promoted storage of retrieved information.

As a further test of the hypothesis that an updating mechanism is operative during retrieval, we examined neural signals during cued recall. Prior studies have described specific signals associated with memory formation and retrieval (Friedman and Johnson, 2000; Paller and Wagner, 2002; Rugg and Curran, 2007), but neural correlates of memory change induced by retrieval are uncommon (Buckner et al., 2001). We determined whether unique electroencephalographic (EEG) signals recorded during retrieval predict subsequent memory for retrieved locations.

Materials and Methods

Participants. Twelve individuals (9 women) from the university community participated. Informed consent was given in advance and payment was provided after completion.

Stimuli. A set of 180 color drawings of objects were used (Rossion and Pourtois, 2004). Objects were presented on a background showing a blue-and-red grid. Each object was presented with a central red dot to indicate its precise location on the grid, which could be anywhere such that the whole object was visible on the background. Dot locations thus appeared in a central 600 × 600 pixel (15.63 × 15.63 cm) region.

Procedure. In session 1, participants learned 180 object-location associations. Each of the 180 objects was associated with a distinct spatial location on the screen. Participants then completed the first of three cued-recall tests (T1), as each object was shown in the center of the screen to serve as a cue to recall the corresponding location. In session 2, a subset of the objects appeared and participants attempted to retrieve associated locations. EEG activity was recorded during this second cued-recall test (T2). In session 3, cued recall was tested for all spatial associations (T3). Each session began ~24 h after the start of the prior session (mean 23.83 h, SE = 0.14).

Testing spatial associations is ideal for providing objective gradations in memory performance. Instead of a binary assessment of memory performance (as in many memory tests) or a subjectively graded response measure (as in recognition with confidence ratings), the distance between the recalled location and the original location provides a graded measure of accuracy. Furthermore, we were also able to evaluate memory on the basis of the extent to which a recalled location was similar to one recalled earlier in response to the same object.

Three experimental conditions were used: Active, Covert, and No Retrieval. In the Active and Covert retrieval conditions, participants were prompted to mentally engage in retrieval during session 2, but they overtly recalled locations only in the Active retrieval condition. We included these two retrieval conditions to determine whether subsequent memory differed as a function of the engagement of overt versus internal retrieval processing. We predicted that recall accuracy during session 3 would be superior for associations retrieved during session 2 than for associations not retrieved during session 2. Because measures of accuracy were obtained at T2 for the Active but not the Covert retrieval condition, the Active condition was of primary interest. Objects were pseudorandomly assigned to each condition, taking recall accuracy at T1 into account so as to equate initial memory strength across conditions. To provide sufficient signal-to-noise ratios for analyses of electrophysiological correlates of active retrieval processing at T2, 120 objects were assigned to the Active condition, leaving 30 for the Covert condition and 30 for the No Retrieval condition.

In session 1 (Fig. 1*A*), participants completed 9 learning blocks, each of which included 20 unique object-location associations. This segmented format for learning allowed participants to learn all 180 associations reasonably well, because objects could be repeated at short delays without too much forgetting or interference. At the beginning of every block, a sequence of 20 new objects was presented in a set of random locations for 2000 ms each. Then, each object was presented in the center of the screen for 500 ms, at which point a sound cue ("click") prompted participants to attempt to move the object to its associated location. Participants dragged the object by operating a computer mouse and clicked the mouse button to indicate their decision. Feedback was provided as the object immediately disappeared from the selected location and reappeared in the correct location. Regardless of response accuracy, the object was shown in this correct location for 2000 ms. After all 20 objects appeared, testing continued with the same set of objects in a different random order. In this way, participants repeatedly practiced retrieval for the same objects via this active recall method to achieve the following learning criterion. A response was considered correct if placed within 150 pixels (3.9 cm) of the correct location. When an object was placed correctly two consecutive times, it was dropped from the learning rotation. Repetitive list presentation continued until all locations in a block were learned to this criterion. Across participants, the number of practice trials completed per object ranged from 2 to 14, with a mean of 2.99 retrieval trials per object (SE = 0.2). After the ninth block, a 15 min break was given, followed by T1, when participants attempted to recall each object's location using the same procedures as during learning except that each of the 180 objects was presented only once and no feedback was provided. At T1, 70% (SE = 4.34%) of the objects were recalled within the learning criterion of 3.9 cm, suggesting that some forgetting occurred following the 15 min post-learning delay.

The following day, participants returned to the lab for session 2 (Fig. 1*B*). EEG was recorded during T2, when objects assigned to Active and Covert conditions appeared in a random order. At the beginning of each trial, a gray screen showed the word "blink," which signaled a rest period and helped to limit blinks and muscle activity during experimental trials. Once ready to proceed, the participant clicked a mouse button and fixated on a cross that appeared in the center of the grid for 1000 ms. Next, objects appeared for spatial-association recall without feedback. For the Active condition, objects were displayed for 1500 ms before a sound cue was played, prompting participants to move the object to its associated location. For the Covert condition, objects were displayed for 2000 ms and then disappeared, ending the trial. Given that the 1500 ms interval at the beginning of each trial was identical in the two conditions, we presume that participants covertly retrieved spatial locations in both conditions, although they actively moved objects to remembered locations only in the Active condition. At T2, 56% (SE = 5.3%) of the Active objects were recalled within the learning criterion.

The next day, participants returned for session 3 (Fig. 1*C*). The final test, T3, was administered using the same procedure used in T1 for all 180 spatial associations. At T3, 53.7% (SE = 4.82%) of the objects were recalled within the learning criterion.

EEG acquisition and analysis. Continuous electroencephalographic activity was recorded during the session-2 cued-recall test using Ag/AgCl active electrodes (BioSemi). Recordings were made from 32 scalp locations (bandwidth DC to 104 Hz, sampling rate 512 Hz). Voltage between each electrode site and a common mode sense electrode was measured and amplified during recording; referencing was accomplished offline by averaging the recordings from the left and right mastoid electrodes. Electrooculographic (EOG) recordings were also made using two electrodes lateral to the eyes and two electrodes situated below the eyes to monitor eye movements and blinks. A high-pass filter (0.1 Hz cutoff, 12 dB per octave roll-off) was applied to the data before analysis.

Event-related potentials (ERPs) extracted from the EEG activity were time-locked to the onset of the centrally presented object cues. ERP analysis was conducted on trials in the Active condition only (120 trials). Epochs lasted 1200 ms, beginning 200 ms before stimulus onset (with baseline correction). Ocular artifacts were detected using a 200 ms moving window with 100 ms steps to identify epochs that exhibited large changes in voltage at the EOG channels. An absolute voltage threshold was applied to the remaining channels to detect exceptionally noisy trials due to head movement or muscle tension. Trials with artifacts were removed (26 trials per participant on average), and exceptionally noisy channels were spatially interpolated (1.4 channels per participant on average). Median splits were relied on for ERP analyses, as described below, with an average of 47 trials included for each condition (see Table

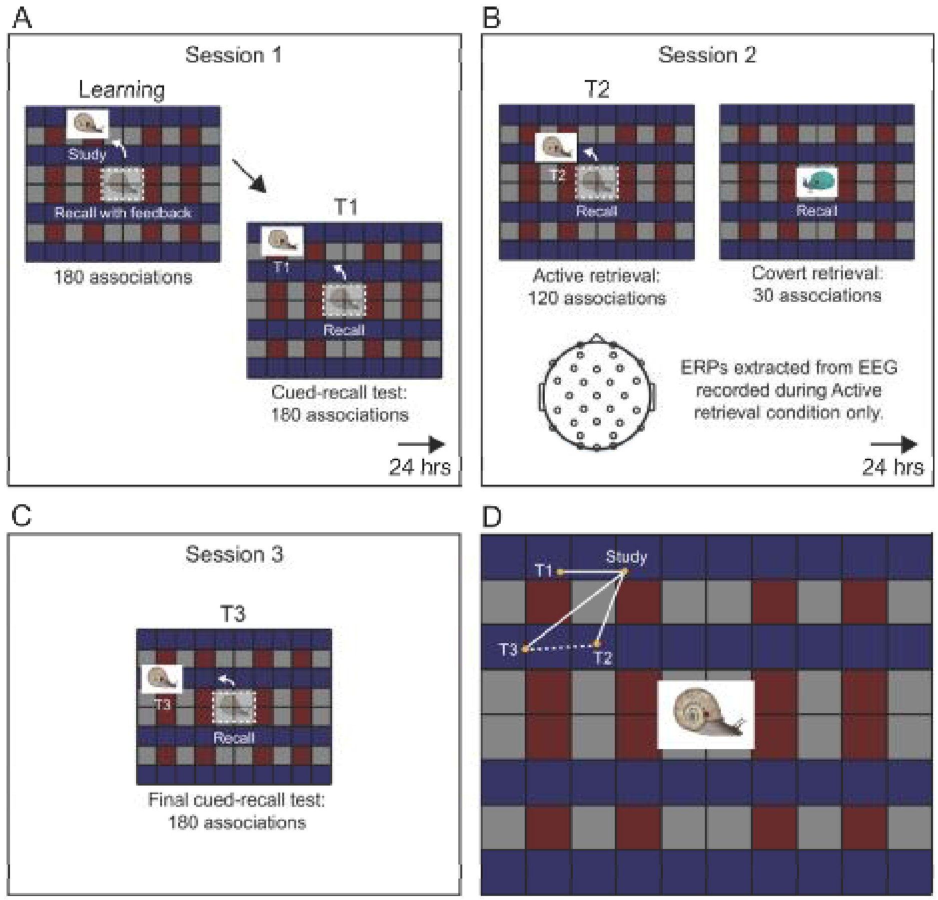

Figure 1. Schematic of the spatial-association task. ***A***, At the beginning of the session-1 learning phase, each object was initially presented in a unique screen location on a 1024 × 768 pixel (26.67 × 20 cm) grid, viewed from a distance of 92 cm. After all learning trials, participants completed the first cued-recall test (T1). In this test, objects were shown in the center of the screen and participants were prompted to move each object to its original location. ***B***, At session 2, EEG was recorded while participants completed the second cued-recall test (T2). For the Active condition, participants viewed each object for 1500 ms and then were prompted to move the object to its original location. For the Covert condition, participants prepared to recall the original location as in the Active condition, and likely attempted to retrieve the location during this time, but they had no opportunity to move the object. Trials in the Active and Covert conditions were randomly intermixed. ***C***, At session 3, participants completed the final cued-recall test (T3). ***D***, The original location for one example object in the Active condition is labeled "Study." Solid white lines depict the distance the object was placed from the study location at each test. Typical errors made on each of the three tests as shown: mean error of 3.59 cm at T1, mean error of 4.73 cm at T2 (Active condition only), and mean error of 5.01 cm at T3. The dashed white line depicts the distance the object was placed from the T2 retrieved location at the final test (retrieval bias distance).

Table 1. Trial sorting conditionalized according to median splits

	Above median (closer)	Median	Below median (farther)
Current accuracy	1.89 (0.27)	3.64 (1.05)	7.57 (0.62)
Future accuracy	2.01 (0.24)	3.74 (1.08)	7.84 (0.59)
Future retrieval bias	0.99 (0.13)	2.14 (0.62)	6.19 (0.67)

For each contrast, trials were distributed into two conditions (Closer/Farther) according to distance measurements. These distance measurements were obtained on the basis of current accuracy, future accuracy, and future retrieval bias. The distance between the T2 recalled location and the study location was used for current accuracy. The distance between the T3 recalled location and the study location was used for future accuracy. The distance between the T3 recalled location and the T2 recalled location was used for future retrieval bias. Trials were assigned to conditions according to whether distances were smaller or greater than the median. Distance values are shown as averaged across participants (measured in centimeters, with SEM).

1 for corresponding behavioral data). A 30 Hz low-pass filter was applied for waveform presentation.

Although few ERP studies have examined neural signals during retrieval that predict subsequent memory performance, many studies have identified potentials during encoding and retrieval that vary as a function of memory success. ERP differences at encoding that predict subsequent memory performance typically arise ~400 ms post-cue onset and are prominent at lateral parietal scalp locations (Paller et al., 1987; Paller and Wagner, 2002). ERPs corresponding to successful recognition of previously studied material tend to exhibit late-positive deflections at both frontal and parietal locations (Friedman and Johnson, 2000; Van Petten et al., 2000; Rugg and Curran, 2007). Accordingly, average amplitudes were computed for two 300 ms time intervals that spanned the mid (400–700 ms) and late (700–1000 ms) phases of the epoch. Regional effects were assessed by collapsing data from eight parietal electrodes (T7, T8, CP5, CP6, P3, P4, P7, and P8) and eight frontal electrodes (FP1, FP2, AF3, AF4, F3, F4, F7, and F8). In reporting ANOVA results, we focus on effects with relevance to memory performance (omitting main effects of time or region). Error probability was adjusted using the Huynh/Feldt correction to account for violations of sphericity (denoted $_{HF}$ when applied to analyses in text).

Results

Behavioral data

Memory accuracy

To determine whether there was a memory benefit from retrieval engaged during session 2, we analyzed recall accuracy for each experimental condition by calculating mean error scores (distance between recalled location and original location, as shown in Fig. 1*D*). After T1, but before the session-2 manipulation, trials were assigned to conditions such that mean accuracy was matched across the three conditions for each participant. A one-way ANOVA confirmed that the mean error at T1 did not differ across conditions ($F_{(1.34,14.73)} = 0.397$, n.s.$_{HF}$).

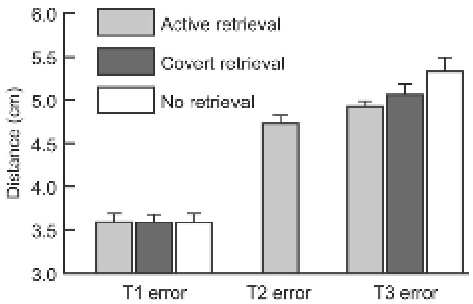

Figure 2. Mean errors in the spatial-association task. Errors on each test (T1, T2, and T3) were computed as the distance objects were placed from corresponding study locations. At T3, forgetting across days was significantly less for objects in the Active Retrieval condition versus the No Retrieval condition. Over all three conditions, errors were greater on T3 than on T1 ($t_{(11)} = 8.77$, $p < 0.001$). For the Active Retrieval condition, errors were greater on T2 than on T1 ($t_{(11)} = 5.07$, $p < 0.001$) and greater on T3 than on T2 ($t_{(11)} = 2.42$, $p < 0.05$). Error bars show SEM after removing across-subject variability.

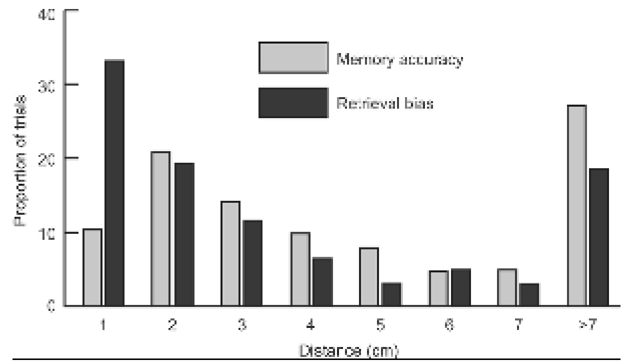

Figure 3. Retrieval bias contrasted with memory accuracy for the Active condition. Locations recalled at T3 were 4.92 cm (SE = 0.06) from the study location on average (memory accuracy) and 3.59 cm (SE = 0.06) from the T2 retrieved location on average (retrieval bias). Bins correspond to the proportion of objects placed fewer than the indicated number of centimeters from the study location or from the T2 retrieved location. Recalled locations were within 1 cm of the T2 retrieved location much more often then they were within 1 cm of the study location.

Given no initial disparities in recall accuracy, we assessed mean errors at T3 for each condition (Fig. 2). As expected, active retrieval at T2 led to an improvement in recall accuracy at T3 compared with no retrieval at T2 ($t_{(11)} = 2.94$, $p < 0.05$). The Covert condition might be expected to include a subset of the processing in the Active condition, and thus also be somewhat beneficial. Indeed, a linear trend was found such that T3 recall was greatest for the Active condition, intermediate for the Covert condition, and lowest for the No Retrieval condition. ($F_{(1,11)} = 8.63$, $p < 0.05$). However, accuracy in the Covert condition did not differ reliably between either of the other two conditions (Covert/Active $t_{(11)} = 0.84$, n.s.; Covert/No Retrieval $t_{(11)} = 1.13$, n.s.). Additional analyses of forgetting across days (subtracting T1 error scores from T3 error scores) confirmed the same patterns of condition effects (as expected given no differential effects at T1).

Retrieval bias

A central goal was to test the hypothesis that retrieval preferentially promotes storage of retrieved information. Because recall at T2 diverged from the original study location on every trial, we were able to use these fine-grained recall measures to determine the extent to which final recall conformed to the T2 retrieved locations. We reasoned that the degree to which objects were placed closer to the T2 locations than to the original study locations was indicative of retrieval-induced distortion. Therefore, we examined final recall performance for the Active condition on the basis of the distance objects were placed from the T2 location for that same object (retrieval bias) and compared these distances to the T3 errors (memory accuracy). Overall, objects were placed significantly closer to T2 locations than to study locations ($t_{(11)} = 8.26$, $p < 0.001$). Analyses of the distribution of responses as a function of distance from the study and T2 locations (Fig. 3) indicated that this effect was driven by trials with the smallest distances. More than 50% of Active objects were placed within 2 cm of the T2 location, whereas ~30% were placed within 2 cm of the study location. Thus, less-than-perfect recall at T2 produced retrieval-induced distortion on the final test, in that recall was biased in the direction of the T2 retrieved locations.

To further interrogate the extent to which retrieval at T2 produced distortion on the final test, we subtracted the retrieval bias distances from the memory accuracy distances to obtain a distortion index for each trial in the Active condition. A distortion index >0 indicates that the object was placed closer to the T2 retrieved location than to the study location, whereas a distortion index <0 indicates that the object was placed closer to the study location than to the T2 retrieved location. On average, 69% of the objects in the Active condition had distortion indices >0, indicating that the majority of objects were placed closer to the corresponding T2 retrieved location than to the study location.

Although distortion on the final test was evident for the majority of objects in the Active condition, one possible scenario is that retrieval-induced distortion occurred primarily on trials when the original location had been forgotten at T2. To systematically determine whether poor accuracy at T2 was a requirement for retrieval-induced distortion, we compared T2 accuracy for objects with a distortion index >0 to T2 accuracy for objects with a distortion index <0. Interestingly, retrieval-induced distortion on the final test did not depend on T2 accuracy; the mean T2 error was 4.68 cm (SE = 0.42) for objects with retrieval-induced distortion and 4.90 cm (SE = 0.53) for objects without retrieval-induced distortion, a nonsignificant difference ($t_{(11)} = 0.49$, n.s.). Thus, the level of accuracy at T2 was nearly the same on trials when distortion was evident versus trials when distortion was not evident, further supporting the notion that retrieval promotes memory for the retrieved information.

Electrophysiology

The Active condition provided an opportunity to interrogate neural signals produced during retrieval at session 2. Relevant neural activity can be contrasted both as a function of current memory performance and as a function of later memory performance. The former contrast should reveal processing correlated with memory retrieval at that moment during T2, whereas the latter contrast may reveal processing that in part determines what will be remembered the next day. ERPs at T2 for the Active condition were thus subjected to analyses as a function of current accuracy, future accuracy, and future retrieval bias. The two future memory contrasts are akin to subsequent memory analyses, in which ERPs at encoding are examined as a function of subsequent memory (Paller and Wagner, 2002), here yielding ERP differences termed Dm for future accuracy and Dm for future retrieval bias.

The behavioral data used to conduct median-split ERP analyses are summarized in Table 1. In the analysis as a function of current accuracy, ERPs were computed using a median split of the T2 errors. We thus compared T2 ERPs for objects placed closer to the original location versus those placed farther from the original location at T2, with closer distances reflecting high accuracy and farther distances reflecting low accuracy. In the analysis as a function of future accuracy, ERPs were computed using a median split of the T3 errors. We thus compared T2 ERPs for objects placed closer to the original location at the next session (high accuracy) to ERPs for objects placed farther from the original location at the next session (low accuracy). In the analysis as a function of future retrieval bias, T2 ERPs were computed using a median split of the retrieval bias distances, which are based on T2 locations rather than original locations. In other words, we compared objects placed closer to the T2 location at the next session to those placed farther from the T2 location at the next session. Based on these measures, we describe closer distances as reflecting high retrieval bias and farther distances as reflecting low retrieval bias.

With these procedures, we used the same trials to examine ERPs on the basis of current accuracy, future accuracy, and future retrieval bias; trials were segregated differently in the three analyses such that the analyses revealed different results. For the current and future accuracy contrasts, 23% of the trials were assigned to different accuracy bins (i.e., high current accuracy and low future accuracy or the reverse). For the current accuracy and future retrieval bias contrasts, 37% of the trials were assigned to different bins (i.e., high current accuracy and low future retrieval bias or the reverse). For the future accuracy and future retrieval bias contrasts, 38% of the trials were assigned to different bins (i.e., high future accuracy and low future retrieval bias or the reverse). Although these trials with different assignments were key to obtaining different ERP results in the three contrasts, it was necessary to use all trials to have sufficient signal-to-noise ratios for ERP measurements.

We conducted a series of analyses separately for each memory contrast. Beginning at 400 ms, mean amplitudes computed over 300 ms intervals were subjected to separate repeated-measures ANOVAs with distance (close, far) and region (frontal, parietal) as independent variables.

Current accuracy

In line with studies that have examined ERPs as a function of successful retrieval (Paller, 2004; Rugg and Curran, 2007), we predicted that current accuracy ERPs would show late positive differences at frontal and parietal sites. If neural reactivation occurs during retrieval (Nyberg et al., 2000; Wheeler et al., 2000; Jacobs et al., 2012), ERPs corresponding to performance differences in current accuracy could reflect reactivation of the original association.

Visual inspection of the current accuracy waveforms indicated prominent differences in latter portions of the recording epoch at frontal and parietal regions (Fig. 4*A*). Indeed, ERPs at 400–700 ms appeared to be more positive for objects recalled at T2 with high accuracy relative to low accuracy. Statistical analysis confirmed that amplitudes were significantly greater for objects placed closer to the original locations relative to those placed farther from the original locations ($F_{(1,11)} = 8.41$, $p < 0.05$). This effect of distance was similar at frontal and parietal sites ($F_{(1,11)} = 1.84$, n.s.). This effect appeared to decline late in the epoch. At 700–1000 ms, neither the main effect of distance nor the interaction with region were significant ($F_{(1,11)} = 1.63$, n.s.; $F_{(1,11)} = 0.06$, n.s.).

Future accuracy

To the extent that retrieval promotes memory for the original association, neural signals at retrieval might differentiate on the basis of subsequent memory for the original study location. Based on visual inspection of the ERPs corresponding to future accuracy, negligible differences were evident during either time interval (Fig. 4*B*). Average amplitudes computed on the basis of future accuracy did not reveal significant differences during any time interval. ERPs corresponding to objects placed closer to the original locations versus those placed farther from the original locations at T3 did not differ at 400–700 ms ($F_{(1,11)} = 0.00$, n.s.) nor 700–1000 ms ($F_{(1,11)} = 0.08$, n.s.). No interactions with region were observed (F values <0.6).

Future retrieval bias

One possible explanation for the lack of ERP differences at session 2 as a function of future accuracy is that neural processing at T2 was not simply devoted to the maintenance of memory for the original object-location association. Processing may have been dominated by the retrieved location, which always diverged from the original location. Accordingly, we hypothesized that ERPs at T2 would uniquely predict the extent to which T3 recall recapitulated T2 retrieved locations.

Visual inspection of ERPs sorted on the basis of future retrieval bias (Fig. 4*C*) indicated differences that emerged at ~500 ms at parietal locations, later at frontal locations, and persisted until the end of the epoch. ANOVA results indicated that amplitudes at 400–700 ms did not differ on the basis of future retrieval bias ($F_{(1,11)} = 2.05$, n.s.), and the interaction with region was not significant ($F_{(1,11)} = 2.99$, n.s.). Amplitudes at 700–1000 ms were greater for objects placed closer to T2 retrieved locations relative to objects placed farther from T2 retrieved locations ($F_{(1,11)} = 7.86$, $p < 0.05$). During the late time interval, this enhanced positivity was similarly evident at frontal and parietal locations ($F_{(1,11)} = 0.08$, n.s.).

Spatial topography: Current accuracy versus future retrieval bias

We hypothesized that distinct mechanisms mediated the current accuracy and future retrieval bias effects. To directly compare these effects topographically, we first calculated difference waves (closer minus farther) for both contrasts (Fig. 5). Difference amplitudes were then normalized according to the procedure recommended by McCarthy and Wood (1985). The comparison of the normalized difference amplitudes at 400–700 ms in a repeated-measures ANOVA with memory contrast and location (32 scalp electrodes) as factors revealed a significant interaction of memory contrast and location ($F_{(16.5,181.47)} = 2.12$, $p < 0.01_{HF}$). Whereas the prior analyses for the interval from 400 to 700 ms showed significant amplitude differences on the basis of current accuracy but not on the basis of future retrieval bias, these results indicate that the spatial topography of these two memory contrasts were also distinct.

Next, we examined whether the two effects differed topographically in the late time interval, when amplitude differences were only observed on the basis of future retrieval bias. At 700–1000 ms, topographical differences across the contrasts were nonsignificant ($F_{(9.81,107.9)} = 0.81$, n.s.$_{HF}$).

Finally, we aimed to determine if the contrasts differed topographically during the time intervals with reliable amplitude effects. We compared the effect based on current accuracy at 400–700 ms with the effect based on future retrieval bias at 700–1000 ms). We observed a nonsignificant interaction of memory contrast and location ($F_{(15.49,170.39)} = 1.6$, $p < 0.077_{HF}$).

Discussion

Neural correlates of retrieval-induced distortion have never been examined previously. Many studies of how retrieval influences

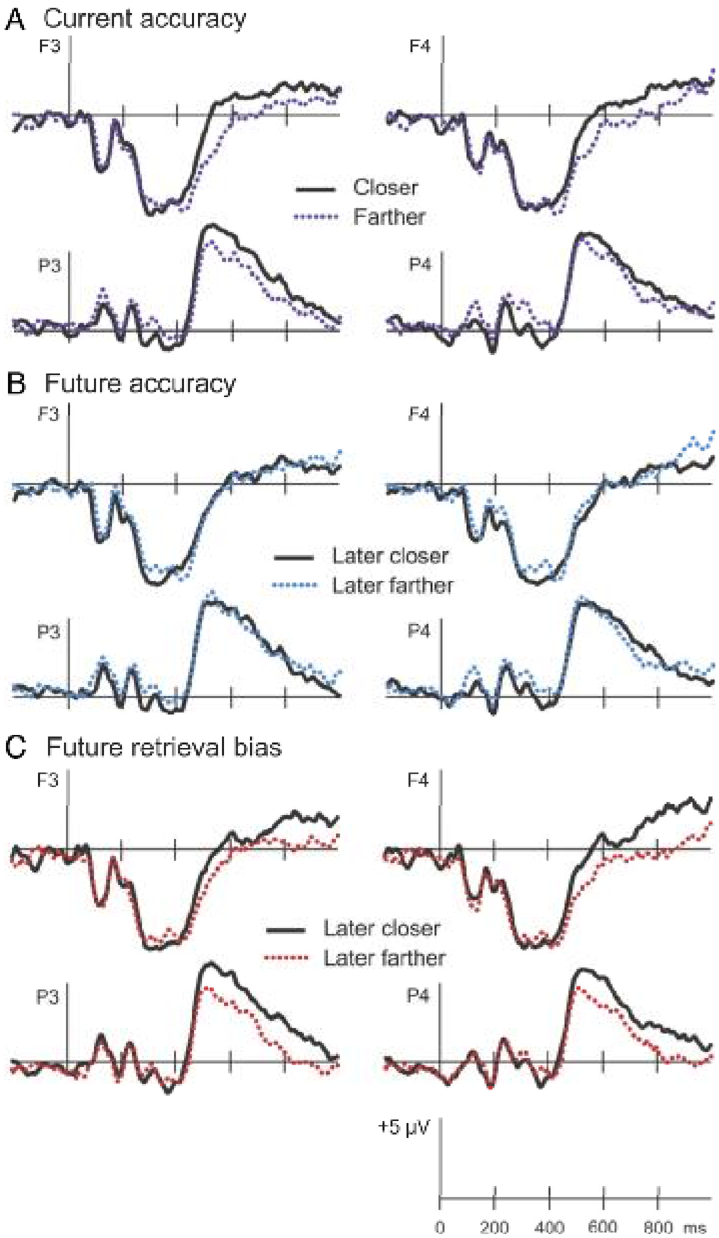

Figure 4. Electrophysiological results. ERPs recorded at session 2 were computed for objects in the Active condition placed closer to (solid lines) or farther from (dotted lines) the corresponding study or T2 locations. ***A***, Current accuracy reflects distance objects were placed from the original location at T2. ***B***, Future accuracy reflects distance objects were placed from the original location at T3. ***C***, Future retrieval bias reflects distance objects were placed from the T2 retrieved location at T3. ERPs from two frontal (F3 and F4) and two parietal (P3 and P4) locations are displayed.

subsequent memory have focused on the "testing effect" (Landauer and Bjork, 1978; Thompson et al., 1978; Carrier and Pashler, 1992; Wheeler and Roediger, 1992; Karpicke and Roediger, 2008; Roediger and Butler, 2011), which refers to the finding that recalling an associate in response to a cue during learning enhances memory storage compared with simply studying a cue-associate pair. Apparently, the testing effect is not completely beneficial. For instance, lures incorrectly selected on an initial multiple-choice test were frequently recalled on subsequent tests (Roediger and Marsh, 2005; Butler et al., 2006; Marsh et al., 2007), suggesting that erroneously retrieved information interferes with future memory performance. Here, recall on T3 was typically off target in the direction of the T2 location, which was not identical to the original location. Accordingly, retrieval did not necessarily reinforce the original association; rather, it altered storage by reinforcing the association that was retrieved on T2.

Indeed, beneficial effects of retrieval on memory may be mediated by (1) reactivation of the original study location and/or (2) storage of the retrieved location, which tends to be related to (but not necessarily identical to) the original location. Although reactivation has been shown to facilitate subsequent memory performance (Rasch et al., 2007; Rudoy et al., 2009; Dupret et al., 2010; Xue et al., 2010), the possibility that retrieval has more complex effects is supported by the finding that brain potentials in the present study corresponding to current accuracy were distinct from those that predicted future retrieval bias. We propose that future recall was not solely dependent upon successful retrieval of the original location; rather, future recall was noticeably influenced by plasticity related to the T2 retrieved location.

As suggested by the retrieval-induced distortion results observed here, retrieval promoted encoding and storage of the retrieval event itself. During retrieval, neural plasticity is enhanced in the CA1 region of the hippocampus (Dupret et al., 2010), which could promote the integration of new information in the context of preexisting memory representations. Indeed, other studies have also shown that encoding processes are operative during retrieval tests (Buckner et al., 2001; Dudukovic et al., 2009). For instance, lures on a recognition test were remembered subsequently on an unexpected memory test, with accuracy comparable to that of items intentionally encoded during a traditional study task (Buckner et al., 2001). These findings fit with the notion that the T2 retrieved location was encoded at the time of testing and subsequently remembered on the final test. However, we cannot rule out the possibility that memory for the original location deteriorated before retrieval at T2, and that retrieval at session 2 provided a rehearsal opportunity for that erroneous location. Regardless of whether the location recalled at T2 was generated just at that moment, the electrophysiological retrieval bias effect signifies processing of the erroneous location that was operative in determining later recall performance. The behavioral results from the final test show unequivocally that recall was biased in the direction of retrieval at T2.

Although performance measures in this spatial memory task were subject to retrieval-induced distortion, retrieval both improved and distorted memory. At session 2, participants revisited the object-location associations they learned the prior day, and this engagement of retrieval facilitated memory accuracy at session 3 (Fig. 2). At the same time, distortion was introduced by retrieval, in that locations recalled at session 3 were biased in the

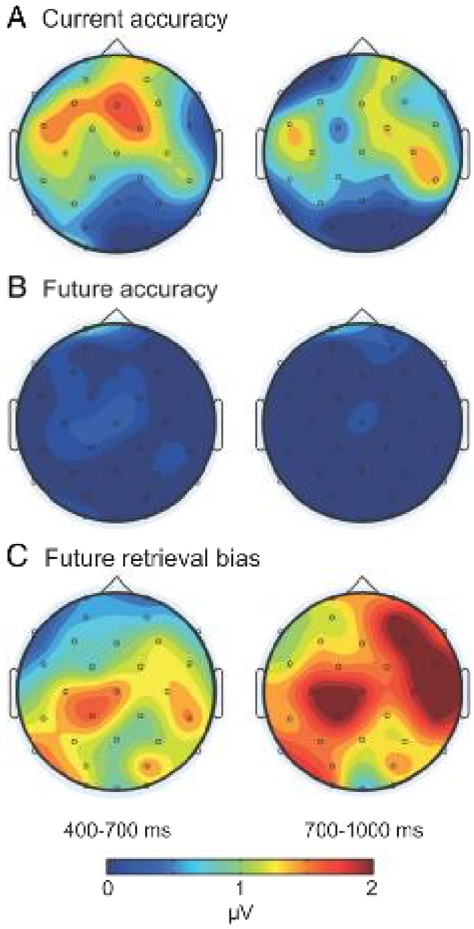

Figure 5. Topographic maps. ***A–C***, Individual maps depict mean amplitude differences at 400–700 ms and 700–1000 ms for the contrast current accuracy (***A***), the contrast future accuracy (***B***), and the contrast future retrieval bias (***C***). Whereas differences tended to be relatively larger at frontal locations for the current accuracy contrast at 400–700 ms, differences were pronounced at most scalp locations at 700–1000 ms for the future retrieval bias contrast.

direction of locations retrieved at session 2 (Fig. 3). Fine-grained measures obtained for each spatial-association recall response provided high sensitivity that revealed this retrieval-induced distortion. Retrieval-induced distortion may be difficult to observe in memory tests that do not provide such fine-grained measures of recall, but it may nevertheless occur widely following intervening retrieval events.

EEG recordings during retrieval provided a novel perspective. Our analysis strategy was to segregate the same set of trials in multiple ways to reveal three different memory relationships. These relationships were thus compared without confounding factors that would have been present if analyses were instead conducted across different participants or different task conditions. Brain activity that predicted recall accuracy at the time of retrieval diverged from brain activity that predicted recall performance the next day. This distinction provides the first isolation of neural activity at retrieval that reflects the incorporation of new—and often erroneous—information into a memory. ERPs predicted not absolute accuracy but the degree to which recall on T3 was biased in the direction of the T2 location. This unique brain activity predicting next-day performance thus constitutes a neural correlate of alterations in memory storage produced by retrieval.

Van Petten et al. (2000) also examined recognition of object-location associations. Participants were required to indicate whether a specific spatial location was that of a specific object viewed earlier. ERP differences similar to those reported here were found, in both cases probably reflecting reconstruction of the prior event. In general, source memory may entail reconstruction of the prior event, including spatial information that is not always precisely correct. Here, recall errors in the final test revealed the consequences of erroneous retrieval for subsequent memory.

Because neural reactivation is generally believed to occur whenever successful retrieval occurs, we infer that ERPs at T2 reflect both attempted reactivation as well as processing of incorrect locations. Neural reinstatement of prior events can occur during successful retrieval (Nyberg et al., 2000; Wheeler et al., 2000; Gelbard-Sagiv et al., 2008; Dupret et al., 2010; Jacobs et al., 2012). For instance, human hippocampal neuronal activity evoked by specific encoding events reemerges before successful recall (Gelbard-Sagiv et al., 2008). Interestingly, reinstatement of hippocampal network activity during retrieval also predicts subsequent memory in animals. After rats learned spatial associations, synchronous firing of CA1 place cells was enhanced when the animal visited reward locations, and this activity correlated with subsequent memory performance (Dupret et al., 2010).

The same mechanism that promotes subsequent memory for errors generated during retrieval may also promote memory for information that is accurately rehearsed during retrieval. If a memory is comprised of several distinct components tied together via hippocampal-based associations such as the unique spatial and temporal context, multisensory information, and emotional content (Bunsey and Eichenbaum, 1996; Eichenbaum et al., 1996), only those aspects that are reinstated during retrieval will be strengthened. For those components that are inaccurately recalled, memory distortion can arise. Therefore, episodic memories may be comprised of a combination of accurate information that was reinforced through retrieval and erroneous information also processed during retrieval. In this way, intervening instances of memory retrieval may be integral to the consolidation process, whereby new information is rapidly learned and integrated with existing representations.

At the final test, object-location associations retrieved at T2 were more accessible than were the originally studied associations. Differences in recall accessibility may have occurred because retrieval modified memory for the original associations, or because it led to the formation of new spatial associations that were remembered on the final test. Future studies should investigate the extent to which neural representations of object-location associations in the hippocampus change with repeated testing. Here we were unable to compare the precise neuroanatomical characteristics of specific memories at encoding and subsequent retrieval events. Future applications of neuroimaging techniques may be useful for determining whether a pattern-separation mechanism is operative during retrieval, such that each retrieval event is represented by a distinct pattern of activity in the hippocampus, or whether retrieval induces a pattern-completion process, whereby original object-location representations are modified to incorporate information generated during retrieval (Yassa and Stark, 2011).

The effect of retrieval-induced distortion is reminiscent of reconsolidation, when remote memories are apparently rendered temporarily labile and susceptible to interference following exposure to a reminder cue. Such changes in memory storage can occur when the hippocampus is no longer required for retrieval, potentially producing memory disruption (Debiec et al., 2002; Nader, 2003) or temporary inaccessibility (Riccio et al., 2006). Unlike studies wherein retrieval was manipulated during the learning phase (Landauer and Bjork, 1978; Thompson et al., 1978; Carrier and Pashler, 1992; Karpicke and Roediger, 2008), here we examined the influence of a delayed retrieval event on subsequent memory for spatial information. Because a 24 h delay followed the encoding session, we can speculate that some consolidation processes took place before the retrieval manipulation at session 2 that promoted the stabilization of the memory for the original location. Accordingly, we showed that individual memories were modified by interference produced at T2, leading to retrieval-induced distortion on T3. We cannot determine whether memory storage was temporarily destabilized during reactivation at session 2, or whether this was merely an opportune time for modification of memory storage in the form of the incorporation of the T2 retrieved location. In either case, this updating mechanism that occurs to memories during retrieval may be a natural component of consolidation that is essential for strengthening some aspects of memory storage while also facilitating the integration of new information.

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APPENDIX B

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Active retrieval facilitates across-episode binding by modulating the content of memory

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ABSTRACT

The contents of memory can be updated when information from the current episode is bound with content retrieved from previous episodes. Little is known regarding factors that determine the memory content that is subject to this across-episode binding. We tested whether across-episode binding preferentially occurs for memory content that is currently "active" and identified relevant neural correlates. After studying objects at specific locations on scene backgrounds, subjects performed one of two retrieval tasks for the objects on different scene backgrounds. In an active condition, subjects recalled object locations, whereas subjects merely dragged objects to predetermined locations in a passive condition. Immediately following each object-location retrieval event, a novel face appeared on a blank screen. We hypothesized that the original episode content would be active in memory during face encoding in the active condition, but not in the passive condition (despite seeing the same content in both conditions). A ramification of the active condition would thus be preferential binding of original episode content to novel faces, with no such across-episode binding in the passive condition. Indeed, memory for faces was better when tested on the original background scenes in the active relative to passive condition, indicating that original episode content was bound with the active condition faces, whereas this occurred to a lesser extent for the passive condition faces. Likewise, early-onset negative ERP effects reflected binding of the face to the original episode content in the active but not the passive condition. In contrast, binding in the passive condition occurred only when faces were physically displayed on the original scenes during recognition testing, and a very similar early-onset negative ERP effect signaled binding in this condition. ERP correlates of binding were thus similar for across-episode and within-episode binding (and were distinct from other encoding and retrieval ERP signals in both cases), indicating that active retrieval modulated when binding occurred, not the nature of the binding process per se. These results suggest that active retrieval promotes binding of new information with contents of memory, whereas without active retrieval, these unrelated pieces of information might be bound only when they are physically paired.

1. Introduction

Binding arbitrarily paired items experienced together during episodes is a central process in many accounts of memory (Underwood, 1969), particularly those of relational memory processing (e.g. Bunsey & Eichenbaum, 1996; Ryan, Althoff, Whitlow, & Cohen, 2000; Eichenbaum & Cohen, 2001; Preston, Shrager, Dudukovic, & Gabrieli, 2004; Prince, Daselaar, & Cabeza, 2005; Ranganath, 2010; Olsen, Moses, Riggs, & Ryan, 2012; Watson, Voss, Warren, Tranel, & Cohen, 2013). Most accounts of binding consider relations among items that co-occur within a spatiotemporal episode. However, it is possible that similar binding mechanisms support updating of memory for previous episodes by linking new information with existing memory content (Bunsey & Eichenbaum, 1996; Zeithamova & Preston, 2010). Although little is known regarding specific factors that influence binding across old and new episodes, some selection factor likely influences binding, such that not all memory content is bound with information in the current episode. One important selection factor could be the extent to which memory content is currently active due to a recent retrieval event (Nader, 2003). Active retrieval relative to passive re-exposure to memory content could be a particularly salient selection factor that determines the memory content subject to binding with new episodic information. That is,

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a targeted memory may be reactivated during active retrieval, but not necessarily during passive re-exposure to the same memory content. For example, we recently demonstrated that active retrieval systematically modulated the contents of memory that were currently active and bound with associatively novel information (Bridge & Voss, 2014).

At least two factors could influence which contents of memory become active: recent encoding or recent reactivation (Lewis, 1979). Binding over short time intervals may occur because recently encountered information stays active in memory for a brief period of time. Thus, as new information is encountered, it is bound to the temporally proximal information. Indeed, items presented in a temporally contiguous sequence are often better remembered later together (Schwartz, Howard, Jing, & Kahana, 2005; Sederberg, Miller, Howard, & Kahana, 2010). Moreover, neural activity reflects the reinstatement of the original temporal context (Turk-Browne, Simon, & Sederberg, 2012), suggesting that items presented close together in time are bound during learning (Briggs, Fitz, & Riccio, 2007). Retrieval may also influence what information is currently active (Briggs & Riccio, 2008). In this case, an old memory becomes active in memory, providing a means by which new information can be integrated into existing representations (Iordanova, Good, & Honey, 2011). Taken together, temporal contiguity may promote encoding of newly encountered information, whereas retrieval may promote updating of existing memories with new information. In both cases, information that is currently active in memory is bound with new information.

We hypothesized that the active engagement of retrieval modulates the extent to which binding between existing representations and new information occurs during learning (across-episode binding). This is because active retrieval could promote reactivation of old representations during encoding of new information, thereby enabling binding. Importantly, we hypothesized that binding would occur between new information that was physically present and old information that was only available in memory. On the other hand, we hypothesized that in the absence of active retrieval during learning, new information would be bound to old information only when these two pieces of information were physically paired during a subsequent test (within-episode binding). Importantly, we use binding to refer to the encoding of the association between two arbitrarily paired episodic elements, in this case a face with a specific object-location-scene context.

We manipulated the engagement of active retrieval processing just prior to encoding novel information. During the Study phase, subjects studied objects in locations on a scene background (original context scene). Then subjects completed a Refresh phase. During Active Refresh, subjects were presented with the objects and asked to actively recall the associated locations. In contrast, during Passive Refresh, subjects moved the objects to predetermined locations. Memory content was thus encountered in both the Active and Passive conditions; however, the extent to which active retrieval processes were engaged varied across conditions. Importantly, in both conditions, the old objects were presented on new scene backgrounds relative to the original study episode, and so original contextual information was not physically present. Furthermore, the same context scene background remained constant throughout each phase; however, the specific object-location information differed on each trial. Immediately following each Active and Passive trial, an unfamiliar face was shown, thus providing new information that could be bound with memory content (i.e. with the original object-location scene association). Face memory was tested in the final phase of the experiment, using either the original or new scene backgrounds. We hypothesized that faces would be preferentially bound to original memory content in the Active condition, thereby yielding better face memory relative to the Passive condition when tested with the original background.

We hypothesized that event-related potentials (ERPs) during face encoding in the Active condition would index across-episode binding between the new faces and the old, reactivated memory content. On the other hand, we hypothesized that ERPs during recognition in the Passive condition would index within-episode binding between the faces and the original memory content when they were physically paired during testing. Importantly, we were able to compare ERPs related to binding to ERPs related to other encoding and retrieval processes by comparing across the Active and Passive conditions. To the extent that similar binding processes were operative for the Active condition during encoding (across-episode binding) and for the Passive condition during recognition (within-episode binding), we expected similarities between these conditions in binding-related ERP correlates.

2. Methods

2.1. Subjects

Data were collected from 24 people (16 women; ages 18–33 years, $M=23$). Two subjects were excluded from all analysis due to failure to follow task instructions, leaving data from 22 subjects for analysis (21 were right handed). All subjects reported no history of neurological or psychiatric conditions and no current use of any psychoactive drugs. Written informed consent was obtained from all subjects prior to participation in accordance with the Northwestern University Institutional Review Board. Subjects were paid for their participation.

2.2. Stimuli

A set of 168 images of real-life objects was used (Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010). Each object was encapsulated by a white box with dimensions of $4.06 \times 4.06\ cm^2$. Eight photographs depicting real-life scenes were used as the background context images (from Hannula, Federmeier, and Cohen (2006)). The screen resolution was 1920×1080 pixels, which occupied $52 \times 29.25\ cm^2$ on an LCD monitor. The refresh rate was 60 Hz. Each object was presented with a red dot marking its center, which could be anywhere such that the whole object was visible on the background. Thus, objects could appear anywhere within the central $46.59 \times 22.75\ cm^2$ area of the screen. A set of 392 nonfamous faces was used (half male, half female; Althoff & Cohen, 1999). Face dimensions during Refresh (face encoding) were $16.25 \times 16.25\ cm^2$ and face dimensions during Recognition were $4.06 \times 4.06\ cm^2$.

2.3. Procedure

Each block was comprised of three phases, Study, Refresh, and Recognition (Fig. 1), each separated by a two-minute distractor task. There were four blocks, two with an Active Refresh phase and two with a Passive Refresh phase. Two scene background images were used in each block (one for Remote Context and one for Proximal Context), with a total of 8 different scenes in the experiment. The distractor task separating each phase involved configuring different block-shapes as they fell from the top of the screen, with the aim of forming complete rows of the block-shapes without any empty spaces (Pfister, 2008).

2.3.1. Study

During Study, subjects viewed objects presented at random locations on a scene background image. The scene background remained on the screen throughout the Study phase as objects were individually presented at randomized locations. A spatial location and scene background combination was thus uniquely tied to each object. We collectively refer to the object-location and Study background scene as the Remote Context (because it was remote relative to face encoding).

There were 42 study trials per block. Subjects were instructed to try to remember each object-location, as they would be given a test on the object locations later during Refresh. A 1000 ms fixation cross preceded each study trial. Then, an object appeared in a random location on the Remote Context scene for 3000 ms.

2.3.2. Refresh

In the second phase of the experiment, subjects completed object Refresh and face encoding. For each trial, subjects were prompted to move an object to a new location. A different scene provided the background during object-location Refresh.

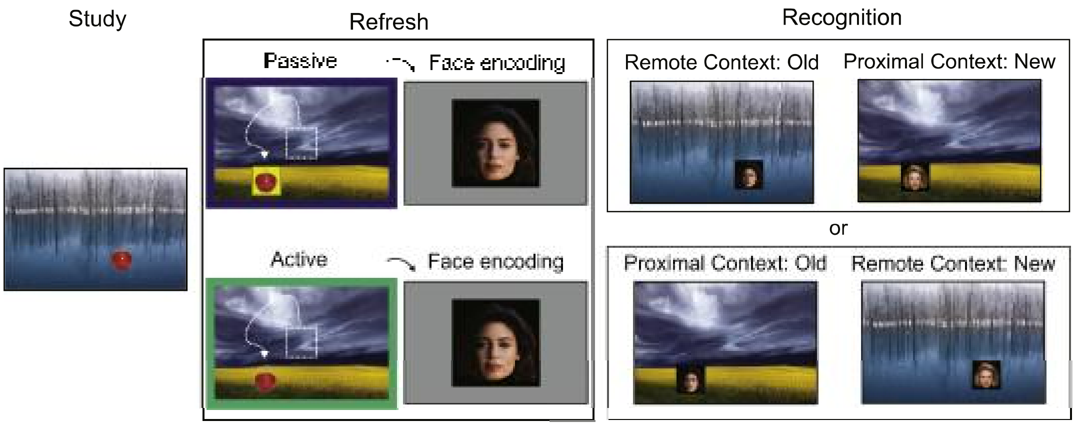

Fig. 1. Experiment design. During Study, subjects viewed objects in random locations on a scene background (Remote Context). During Refresh, subjects studied centrally presented faces on a gray background. Before each face onset, subjects completed a Passive or Active reactivation task with the studied objects on a different scene background (Proximal Context). In the Passive condition (depicted in top panel), subjects moved the object to a predetermined location. In the Active condition (shown in bottom panel), subjects recalled the object's location and then moved it accordingly (recall was always inaccurate to some extent, see Section 2). During Recognition, memory of the faces was tested in either the Remote Context or Proximal Context. If an old face was tested in the Remote Context, then a new face was tested in the corresponding Proximal Context (example shown in top panel). Alternatively, if an old face was tested in the Proximal Context, then a new face was tested in the corresponding Remote Context (example shown in bottom panel). Face-scene pairings were individually presented during the Recognition phase. Both possible Refresh and Recognition options are shown for each face (for illustration purposes), although only one option was used for each face in the experiment (see Section 2). ERPs were time-locked to face onset during Refresh and Recognition.

We collectively refer to the new object location and the Refresh background scene as the Proximal Context (because it was proximal to face encoding). Immediately following each object Refresh trial, a new face appeared on a neutral gray background. Each face was presented immediately following an object-location reactivation event; however, the extent to which active retrieval processing was engaged prior to face encoding differed as a function of Refresh condition (described below).

A jittered fixation cross (500–1000 ms) preceded each object Refresh trial. Then, a centrally presented object (from the preceding Study phase) appeared on the screen and subjects were prompted to move the object to a new location using a mouse. After an object was placed, it remained in that location for 800 ms, ending the trial. Immediately following the end of the object Refresh trial, a gray background appeared with a central fixation cross for 800 ms. Then, a centrally-presented face appeared for 3000 ms on the neutral background. For each face, subjects made a button press to indicate whether they would cast the person pictured in a "comedy" or "drama" production. This face categorization task was used to boost encoding of the faces. Different objects, scenes, and faces were randomly assigned to the Active or Passive Refresh condition.

Active Refresh. During Active Refresh, subjects were instructed to recall each object's associated location on the Proximal Context background scene. Although they were not explicitly told to recall the objects' associated background scene, it is likely that the Remote Context scene was reactivated during this time in order to help guide subjects' object-location recall. Subjects dragged the object from the center of the screen to its associated location then pressed a button. The precise placement of the object (the recalled location) always diverged from the location at Study to some extent (M = 10.05 cm, SE = .64) due to forgetting. Divergence distances (i.e., placement error) for the objects were used to generate the location of objects during the Passive Refresh condition (see also Bridge and Voss (2014)), such that divergence distances were matched within-subjects for the Active and Passive conditions.

Passive Refresh. During Passive Refresh, subjects were prompted to move each object from the center of the screen to a predetermined location on the Proximal Context background scene. Because subjects were not required to recall the objects' associated locations, it is likely that reactivation of the original object-location-scene episode (Remote Context) was reduced during Passive relative to Active Refresh. The centrally presented object was accompanied by the presentation of a yellow target box in a predetermined location and subjects moved the object to the box and pressed a button. Placement within .5 cm of the center point of the yellow box was required for the response to be accepted. After the response was accepted, the object moved to the center of the yellow box until the end of the trial. Subjects were told that the yellow box would be located in the original study location for some of the trials and located in a novel location on other trials, analogous to ranging levels of recall accuracy in the Active condition. The mean divergence distance for the Passive Object-Refresh condition was M = 10.06 cm, SE = .64, which did not differ from the Active divergence distances [$t(21)$ = .26, *ns*]. Because we used a matching scheme to generate the Passive divergence distances, the first block was always with Active Refresh and the last block was always with Passive Refresh. The order (Active or Passive) of the two intermediate blocks was counterbalanced across subjects.

2.3.3. Recognition

During each face Recognition test block, subjects saw 42 old and 42 new faces and indicated whether or not they remembered seeing each face. Half of the old and new faces were tested in the Remote Context and the other half were tested in the Proximal Context. That is, faces were tested in either the original object-location and scene background (Remote Context) or they were tested in the newer Refresh object-location and corresponding scene background (Proximal Context). Thus, the test face was directly tied to either the original object-location-scene or the newer Refresh object-location-scene association.

A fixation cross superimposed on the upcoming Recognition trial scene background preceded each face Recognition trial. The fixation cross was presented in the center of the screen for 1000 ms. Then, in order to orient attention to the location of the face for the upcoming Recognition trial, the fixation cross flashed once (150 ms on, 150 ms off) in either the Remote Context or Proximal Context location while the background scene remained constantly visible. The fixation cross remained in that location for an additional 800 ms. A face then appeared in the Remote Context or Proximal Context location for 1000 ms. Then, text appeared at the bottom of the screen, prompting the subjects to indicate if the face was "old" or "new" by clicking a button on the mouse. After a response was made, the text changed, prompting the subjects to press a button indicating their level of confidence in their recognition decision, either "low", "medium", or "high". After recognition memory confidence was indicated, the trial ended.

2.4. Behavioral analysis

Hit rates were calculated as the percentage of correctly endorsed old faces for each Refresh condition (Active versus Passive), test context (Proximal versus Remote), and confidence level (low, medium, high). False alarm rates were determined for each condition for new faces incorrectly endorsed as "old." Normalized hit and false alarm rates were used to calculate d' scores for each condition, response confidence level, and subject. In order to correct for any extreme hit and false alarm values (i.e. 1 or 0), we computed all d' values according to the procedure suggested by Snodgrass and Corwin (1988).

2.5. EEG acquisition and ERP analysis

Continuous EEG was recorded during the Refresh and Recognition phases using Ag/AgCl active electrodes (actiCAP, Brain Vision LLC). Recordings were made from 30 scalp locations (bandwidth DC to 20,000 HZ, sampling rate 1000 Hz). EEG signals were amplified and digitized online. Recordings were made referenced to right mastoid, and referenced offline to averaged mastoids. Electrooculography (EOG) recordings were also made using two bipolar electrodes at left and right outer canthi and two bipolar electrodes situated above and below the left eye to monitor eye movements and blinks. A high-pass filter (.1 Hz cutoff, 12 dB per octave roll-off) was applied prior to analysis.

Event-related potentials (ERPs) were time-locked to the face onset in the Refresh and Recognition phases. Epochs lasted 1200 ms, beginning 200 ms before stimulus onset, with baseline correction using the prestimulus interval. Trials with ocular artifacts were rejected as indicated by large voltage offsets within 200 ms moving windows. An absolute voltage threshold was also applied to the scalp electrodes to identify and reject noisy trials due to massive head movements and muscle tension. Exceptionally noisy channels were spatially interpolated (ranging from 0 to 1 channels per subject).

We used ERPLAB for all preprocessing steps and ERP analysis (Lopez-Calderon & Luck, 2014). We examined mean amplitude during a priori time windows to determine differences due to memory across conditions. Early negative potentials beginning ~150 ms are often elicited during visual processing of faces (e.g. Rossion & Jacques, 2011); therefore we analyzed ERPs beginning at 150 ms after face onset, in order to determine if Refresh condition influenced early face processing (between 150 and 400 ms). Based on other ERP face recognition studies (Yovel & Paller, 2004), we also chose to examine differences during mid (400–600 ms) and late (600–800 ms) time intervals during encoding as a function of subsequent memory, and between 500 and 700 ms during Recognition as a function of face memory.

For these targeted analyses, we formed five regionally defined clusters of electrodes distributed across the scalp. We assessed midline effects by collapsing data from frontal (FP1, FP2, F3, F4, FZ), central (FC1, FC2, C3, C4, CZ), and parietal sites (CP1, CP2, P3, P4, PZ). We assessed lateral effects by collapsing data from left (F7, FT9, FC5, T7, CP5, P7) and right sites (F8, FT10, FC6, T8, CP6, P8). We report significant differences only with respect to memory performance. Error probability was adjusted using the Greenhouse–Geisser correction to account for violations of sphericity (denoted GG when applied to analyses in text).

During face encoding, we compared ERPs corresponding to faces that were subsequently remembered on the recognition test to ERPs corresponding to faces that were subsequently forgotten, termed subsequent memory effects or "Dm," for "Differences due to later memory" (Paller, Kutas, & Mayes, 1987; Paller, McCarthy, & Wood, 1988; Paller & Wagner, 2002). Subsequent memory effects were examined irrespective of later test context. During Recognition, we compared ERPs corresponding to correctly identified old faces (hits) to ERPs corresponding to correctly identified new faces (correct rejections). We refer to significant differences between correctly identified old faces and correctly identified new faces as "ERP old/new effects". We examined ERP old/new effects separately for each test context.

Subjects with fewer than 10 trials in a critical condition were excluded from the corresponding ERP analysis. Data from 17 subjects were included in the Dm analysis, and data from 20 subjects were included in the context-specific Recognition memory analysis. Targeted follow-up analyses were also performed to compare among effects individually identified during Refresh versus Recognition, and these analyses included only subjects that contributed to both effects (i.e., so that comparisons among phases utilized within-subjects tests). See Table 1 for the mean number of ERP trials per condition.

3. Results

3.1. Behavioral results

3.1.1. Effects of active versus passive refresh on recognition sensitivity

We hypothesized that active retrieval would facilitate binding of newly encountered information with memory content that was currently active; therefore, we expected that Active Refresh would selectively facilitate face recognition memory for the Remote Context. To test this hypothesis, we examined recognition memory performance by computing d' as a function of Refresh condition (Active, Passive), test context (Remote Context, Proximal Context), and confidence level (low, medium, high) (Table 2). There was a significant main effect of Refresh condition, indicating that d' was significantly higher for the Active (M=.64, SE=.06) relative to the Passive (M=.51, SE=.07) condition [$F(1,21)=5.88$, $p<.03$]. This main effect was qualified by an interaction of Refresh condition and test context [$F(1,21)=5.17$, $p<.04$] (Fig. 2). For recognition in the Remote context, d' was significantly higher for the Active (M=.69, SE=.06) relative to the Passive condition (M=.48, SE=.08) [$t(21)=3.12$, $p<.006$]. On the other hand, for recognition in the Proximal Context, d' did not differ for the Active (M=.59, SE=.07) and Passive (M=.54, SE=.06) conditions [$t(21)=.78$, ns]. Within each Refresh condition, d' did not differ significantly for test contexts [Active: $t(21)=1.71$, ns; Passive: $t(21)=1.31$, ns].

There was also a marginally significant interaction of confidence level and Refresh condition [$F(1.99, 41.87)=3.13$, $p=.054_{GG}$] (Table 2). For high confidence responses, d' was significantly higher for the Active relative to the Passive condition [$t(21)=3.55$, $p<.002$]. Recognition d' did not differ for Active and Passive conditions for either medium [$t(21)=.30$, ns] or low confidence responses [$t(21)=1.39$, ns]. Unsurprisingly, there was a main effect

Table 1
ERP trial counts.

	Active		Passive	
	Hits	Misses	Hits	Misses
Dm (all contexts)	44.59 (27–63)	20.18 (10–34)	46.82 (25–60)	20.29 (11–30)
	Hits	CRs	Hits	CRs
Recognition: Remote Context	24 (16–33)	25.4 (13–34)	23 (14–34)	22.3 (12–32)
Recognition: Proximal Context	25.3 (14–37)	25.7 (14–33)	24.15 (13–34	22.9 (14–31)

Note: Mean trial numbers with range of trials in parentheses.

Table 2
Hits and false alarms as a function of Refresh condition, test context, and confidence level.

	Active								
	High confidence			Medium confidence			Low confidence		
	Hits	FA	d'	Hits	FA	d'	Hits	FA	d'
Remote Context	.37(.03)	.04(.01)	1.45(.11)	.22(.02)	.11(.02)	.51(.10)	.13(.01)	.11(.01)	.10(.07)
Proximal Context	.37(.03)	.06(.01)	1.29(.12)	.22(.02)	.13(.02)	.36(.10)	.13(.02)	.09(.01)	.12(.10)
	Passive								
	High confidence			Medium confidence			Low confidence		
	Hits	FA	d'	Hits	FA	d'	Hits	FA	d'
Remote Context	.37(.04)	.09(.02)	1.08(.11)	.21(.02)	.12(.02)	.39(.11)	.13(.02)	.13(.02)	−.01(.10)
Proximal Context	.37(.03)	.08(.02)	1.17(.10)	.21(.02)	.11(.02)	.44(.09)	.12(.01)	.13(.02)	.02(.08)

Note: Means with standard error in parentheses.

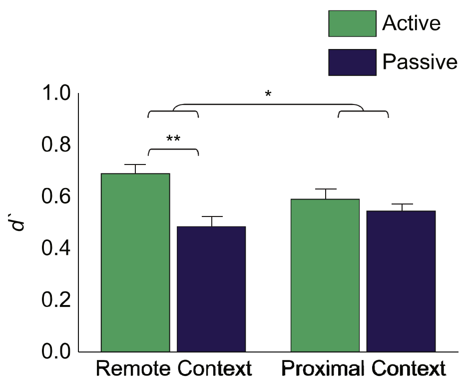

Fig. 2. Face recognition memory performance for the Active and Passive conditions subdivided by testing context. d' collapsed across confidence level; plotted as a function of Refresh condition and test context. $^{**}p<.01$; $^{*}p<.05$.

of confidence on d' $F(1.93,40.48)=128.51$, $p<.001_{GG}$]. Recognition d' was significantly greater for high confidence ($M=1.25$, $SE=.09$) relative to medium confidence ($M=.43$, $SE=.08$) [$t(21)=10.06$, $p<.001$] and low confidence ($M=.06$, $SE=.06$) responses [$t(21)=15.53$, $p<.001$]. Recognition d' was also greater for medium confidence responses compared to low confidence response [$t(21)=5.31$, $p<.001$].

3.1.2. *Effects of active versus passive refresh on hits and false alarms*

We next examined raw recognition performance as a function of Refresh condition, test context, and confidence level for hits and false alarms separately (Table 2). We subjected hit rates to a repeated-measures ANOVA with Refresh condition, test context, and confidence level as factors. No effects involving Refresh condition were significant on hit rate. Unsurprisingly, there was a main effect of confidence on hit rates [$F(1.49,31.25)=30.81$, $p<.0001_{GG}$], given that high confidence hit rate was greater relative to medium [$t(21)=4.10$, $p<.001$] and low confidence hit rates [$t(21)=7.79$, $p<.0001$]. Additionally, hit rate was greater for medium relative to low confidence responses [$t(21)=3.80$, $p<.01$]. No other effects on hit rate were significant.

We also examined false alarms with a repeated-measures ANOVA with Refresh condition, test context, and confidence level as factors. The main effect of Refresh condition was significant [$F(1,21)=5.70$, $p<.03$], indicating that false alarm rate was significantly higher in the Passive condition (M=.11, SE=.01) relative to the Active condition (M=.09, SE=.01). The main effect of confidence was also significant, in that false alarm rate was lower for high relative to medium [$t(21)=2.95$, $p<.01$] and low confidence responses [$t(21)=2.23$, $p<.04$]. False alarm rate did not differ between medium and low confidence responses [$t(21)=.12$, *ns*]. No other effects on false alarm rate reached significance ($Fs<2.68$).

In summary, these behavioral effects show that overall face memory was enhanced when encoding followed Active rather than Passive object-location Refresh. Interestingly, this memory enhancement was pronounced when faces were tested in the original object-location context, despite the fact that these faces were never studied at these locations when first encountered (i.e., presentation was central when faces were encoded). This suggests that Active retrieval selectively facilitated binding between existing memory traces and new, unrelated face information. These effects were driven by the higher false alarm rate in the Passive relative to the Active condition, indicating overall weaker face memory in the Passive condition. It is possible that the familiarity of the context scenes made face memory decisions more challenging in the Passive condition, due to weaker face-context binding relative to the Active condition. That is, the highly familiar scenes could have caused subjects to endorse new faces as old more frequently because binding between individual faces and scenes was overall weaker in the Passive condition and did not override this influence of context familiarity on face endorsement, as it might have in the Active condition. We next sought to determine when binding between the faces and the Remote Context occurred in each condition by examining ERPs time-locked to face onset during encoding and Recognition.

3.2. *ERP results*

3.2.1. *Overview of ERP comparisons and predictions*

To identify ERP correlates of face-context binding, we examined Dm effects for the Active and Passive Refresh conditions. Critically, we hypothesized that Refresh condition would modulate the extent to which the original object-location context (Remote Context) was bound to the faces during encoding. We predicted that across-episode binding would be enhanced in the Active condition, because the Remote Context was active in memory during face encoding (Fig. 3). We expected that this binding-related effect would be distinct from typical encoding effects, which we determined by comparing Dm effects for the Active

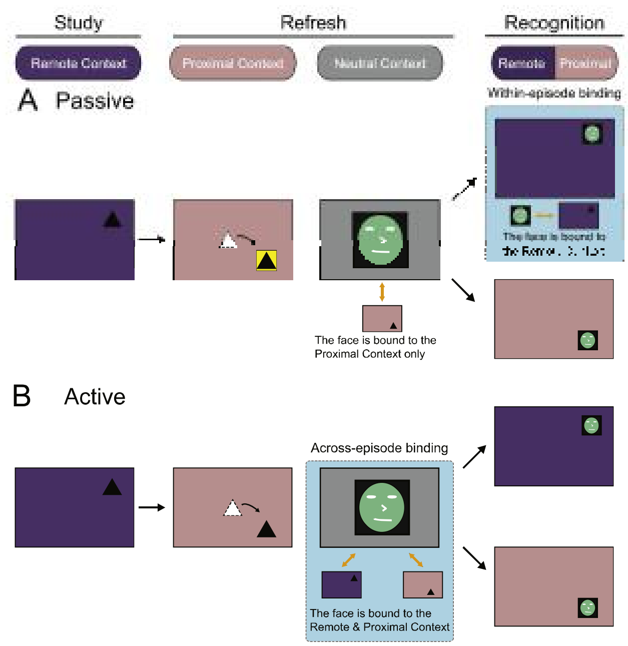

Fig. 3. Hypothesized ERP effects related to across- and within-episode binding. We predicted that faces would be bound to the Remote Context during face encoding in the Active condition (across-episode binding), and during face recognition in the Passive condition (within-episode binding). We expected that faces would always be bound to the Proximal Context during face encoding, because it was active in memory due to temporal proximity. Orange bi-directional arrows between the faces and contexts depict hypothesized binding. The teal backgrounds denote binding between the faces and the Remote Context. Purple boxes represent the Remote Context scene, red boxes represent the Proximal Context scene, and the black triangles represent the objects and their locations. (A) In the Passive condition, we did not expect binding to occur during face encoding, because the Remote Context was not active in memory during Refresh. Instead, we predicted that faces would be bound to the Remote Context during Recognition, when the faces and contexts were physically presented together (within-episode binding). We expected that Remote Context-specific ERPs during Recognition would reflect binding when faces were successfully recognized. (B) In the Active condition, we predicted that binding between the faces and the Remote Context would occur during face encoding because the Remote Context was active in memory during Refresh via reactivation (across-episode binding). We hypothesized that subsequent-memory ERPs would reflect binding between the faces and the Remote Context during encoding. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

versus the Passive Refresh conditions. On the other hand, we expected that reactivation of the Remote Context was minimal during Passive Refresh; thus, we hypothesized that binding between the face and the Remote Context would not occur until they were physically paired later in the experiment during Recognition (within-episode binding). Accordingly, we predicted that old/new ERP effects from Recognition in the Remote Context would reflect binding between the face and the original context in the Passive condition.

Finally, we predicted that binding between the faces and the Proximal Context would always occur during Refresh (irrespective of condition). Because information within the surrounding temporal context is likely bound during encoding (Sederberg et al., 2010), we expected that these binding-related effects would elicit ERPs consistent with other encoding processes (i.e., not related to the binding that is the focus of this study) that are frequently identified in ERP studies of memory encoding. We therefore hypothesized that these temporal proximity-based binding effects would be distinct from the across- and within-episode binding effects described above. Specifically, whereas we expected that temporal proximity-based binding effects would resemble typical Dm effects, we hypothesized that across- and within-episode binding effects would elicit unique ERPs, because this is a distinct form of binding.

3.2.2. Face encoding ERPs

Active Refresh. Visual inspection of the Active Refresh waveforms (Fig. 4A) indicated an early Dm effect beginning as early as 150 ms at frontal sites and appearing to last until ~400–500 ms. An interaction of region and accuracy [$F(2.79,44.57)=3.18$, $p<.05_{GG}$] between 150 and 400 ms, indicated that mean amplitudes corresponding to subsequent hits were significantly more negative relative to mean amplitudes corresponding to subsequent misses at frontal [$t(16)=3.32$, $p<.005$] and central electrode sites [$t(16)=2.15$, $p<.05$]. Mean amplitudes did not differ during this early time interval at any other region ($ts<1.49$). Although there was a trend, the main effect of face accuracy was not significant during this early time interval [$F(1,16)=4.44$, $p<.06$]. No significant Dm effects were apparent during the 400–600 ms interval ($Fs<2.72$) or the 600–800 ms interval ($Fs<.90$). These results indicate that early negative differences at frontocentral electrode sites predicted subsequent memory in the Active condition. Late positive differences typically observed during encoding in other settings (e.g., Rugg & Curran, 2007) were absent in this contrast. These results suggest that a novel binding mechanism may be operative during face encoding following Active Refresh to promote subsequent memory.

Passive Refresh. Visual inspection of the Passive Refresh waveforms indicated late positive differences as a function of subsequent face memory (Fig. 4B). Indeed, no differences were observed as a function of subsequent memory between 150 and 400 ms ($Fs<2.00$), or 400–600 ms ($Fs<2.90$). However, during the late time interval (600–800 ms), mean amplitudes corresponding to subsequent hits were significantly more positive relative to mean amplitudes corresponding to subsequent misses [$F(1,16)=8.53$, $p<.01$]. The interaction with electrode site was not significant [$F(1.93,30.87)=.80$, ns_{GG}]. These Dm effects are consistent with other ERP studies generally (Rugg & Curran, 2007), and specifically with those examining subsequent memory effects for faces (Yovel

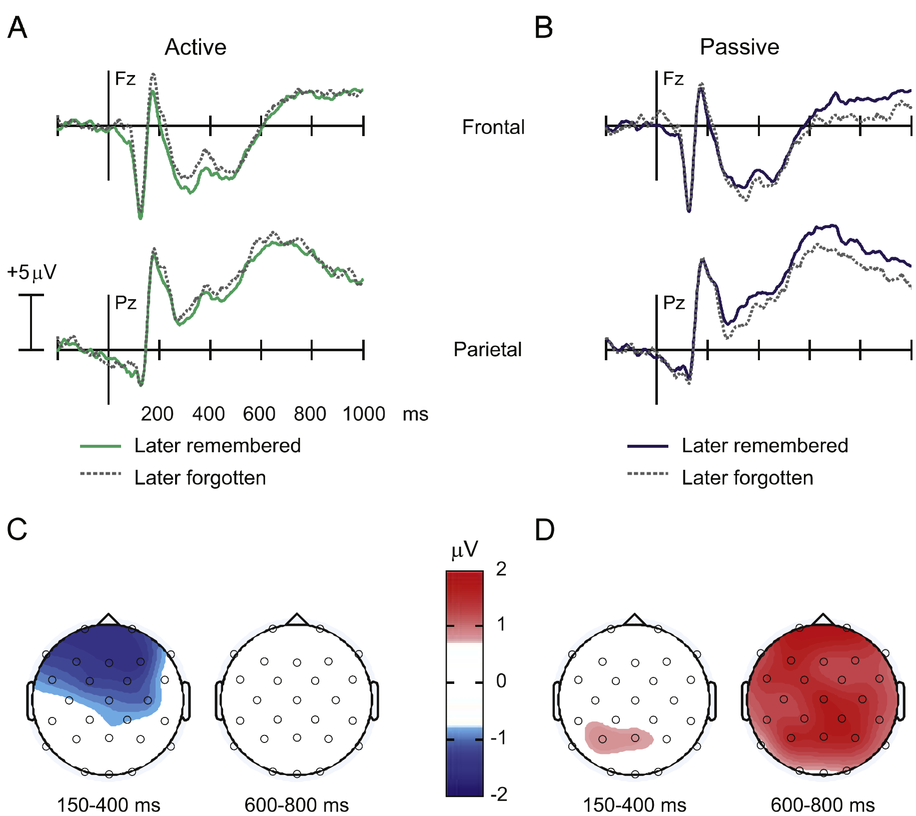

Fig. 4. Dm effects. ERPs time-locked to faces during encoding as a function of subsequent memory. (A, B) Dark solid lines depict later remembered faces; dashed gray lines depict later forgotten faces for the (A) Active and (B) Passive condition. (C, D) Topographic maps depict the difference between later remembered and later forgotten faces for the (C) Active and (D) Passive condition. Whereas negative differences between 150 and 400 ms predicted subsequent memory of the faces in the Active condition, positive differences between 600 and 800 ms predicted subsequent memory of the faces in the Passive condition.

& Paller, 2004), suggesting that ERPs predictive of successful face memory were apparently unaffected by the preceding Passive Refresh task.

Active versus Passive Dm effects. We compared the Active and Passive Dm effects to test our prediction that different processes were operative during face encoding across Refresh conditions. To do this, we first calculated difference waves (later-remembered minus later-forgotten faces) during the time intervals with reliable differences for each condition, and we used the regional clusters used for the targeted analysis above. We thus compared the Active Dm effect (150–400 ms) (Fig. 4C, left panel) to the Passive Dm effect (600–800 ms) (Fig. 4D, right panel). A main effect of Refresh condition indicated that mean differences predictive of later memory were significantly more positive in the Passive relative to the Active

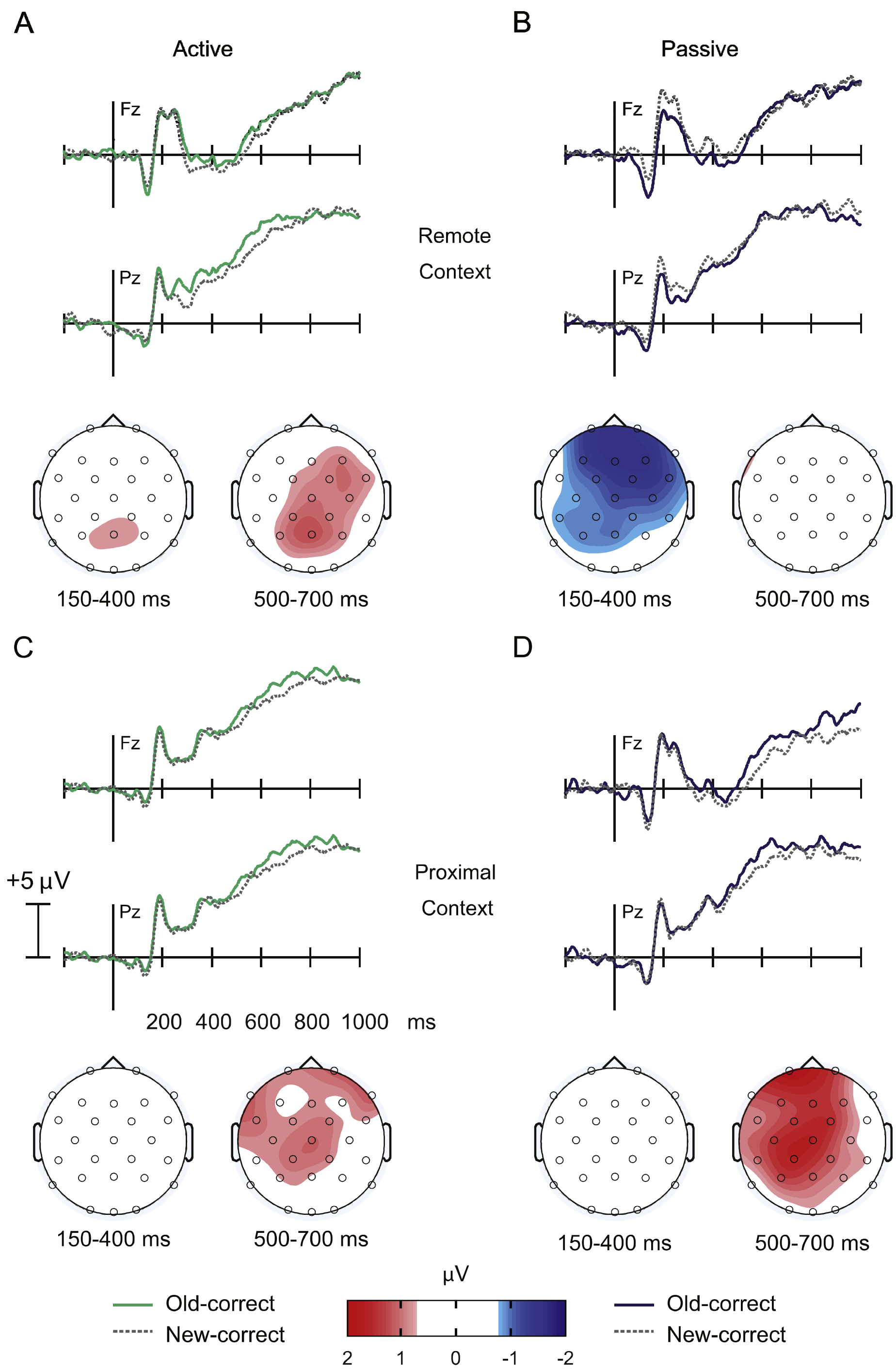

Fig. 5. Context-dependent old/new ERP effects. Mean amplitudes during Recognition plotted as a function of test context. (A, B) Remote Context old/new effects for the (A) Active and (B) Passive conditions. (C, D) Proximal Context old/new effects for the (C) Active and (D) Passive conditions. Early negative old/new differences for evident only for the Passive condition in the Remote Context, suggesting that binding between face and context occurred at this time. On the other hand, late positivity effects reflected successful recognition memory for the Passive condition in Proximal Context and for the Active condition in both test contexts, suggesting that successful retrieval of the existing face-context representations occurred for these conditions.

condition [$F(1,16)=11.10$, $p<.005$]. There was also a nonsignificant interaction of Refresh condition with region [$F(2.34,37.39)=2.89$, $p<.07_{GG}$]. Dm effects differed significantly between the Refresh conditions at all regional sites ($ts>2.60$, $ps<.02$). These results suggest that distinct processes were operative during encoding that predicted later memory of the faces as a function of Refresh condition. We hypothesize that differences across conditions during face encoding arose because faces were selectively bound to the Remote Context in the Active condition (Fig. 3B).

3.2.3. Face recognition old/new ERPs

We reasoned that context-specific ERPs during Recognition would indicate whether or not face-context binding occurred earlier in the experiment during face encoding. Specifically, we hypothesized that ERPs corresponding to successful recognition of the faces in the Remote Context would reflect face-context binding for the Passive condition only (Fig. 3A). For all other contrasts, (i.e. Passive recognition in the Proximal Context, and Active recognition in the Remote Context and Proximal Context) we expected that ERP old/new effects would simply reflect successful retrieval (as binding presumably occurred previously for these conditions). To test this hypothesis, we examined mean amplitudes for each test context and for each condition.

Active: Remote Context old/new ERP effects. We did not observe any significant old/new effects for the Active condition between 150 and 400 ms ($Fs<1.35$). Between 500 and 700 ms, there was a nonsignificant interaction with region in the Remote Context [$F(2.55,48.40)=2.42$, $p<.09_{GG}$]. Mean amplitudes corresponding to old-correct faces tended to be more positive at parietal sites relative to mean amplitudes corresponding to new-correct faces [$t(19)=2.05$, $p<.055$] (Fig. 5A).

Active: Proximal Context old/new ERP effects. Similar to the Active Recognition results for the Remote Context, we did not observe any significant old/new effects between 150 and 400 ms ($Fs<1.04$). Between 500 and 700 ms, there was a main effect of face condition, such that mean amplitudes corresponding to old-correct faces were significantly more positive relative to mean amplitudes corresponding to new-correct faces [$F(1,19)=6.61$, $p<.02$] (Fig. 5C).

Therefore, no early negative old/new effects were observed during Recognition in the Active condition, irrespective of test context. On the other hand, late positive old/new effects were apparent in the Active condition marginally in the Remote Context and significantly in the Proximal Context (Fig. 5A and C), suggesting that this late positivity reflects successful retrieval of the bound face-context associations.

Passive: Remote Context old/new ERP effects. Consistent with our hypothesis that face-context binding occurred selectively for the Passive condition in the Remote Context, a main effect of face condition between 150 and 400 ms indicated that mean amplitudes corresponding to old-correct faces were significantly more negative relative to mean amplitudes corresponding to new-correct faces [$F(1,19)=6.33$, $p<.03$] (Fig. 5B). The interaction of face condition and region was not significant [$F(2.75,52.27)=1.95$, *ns*]. During the later time interval, no old/new effects were apparent ($Fs<1.53$).

Passive: Proximal Context old/new ERP effects. Between 150 and 400 ms, there was a significant interaction of face condition with region [$F(2.70,50.34)=3.17$, $p<.05_{GG}$]. However, old/new effects were not significant at any region during this time interval ($ts<1.39$). Between 500 and 700 ms, there was a significant effect of face condition, indicating that mean amplitudes corresponding to old-correct faces were significantly more positive relative to mean amplitudes corresponding to new correct faces [$F(1,19)=4.86$, $p<.05$] (Fig. 5D). The interaction of face condition with region was also significant [$F(2.45,50.29)=3.16$, $p<.05_{GG}$], such that old/new effects were significant at frontal [$t(19)=2.11$, $p<.05$], central [$t(19)=2.40$, $p<.03$], and parietal sites [$t(19)=2.53$, $p<.03$], but not at lateral sites ($ts<1.70$). Thus, unlike recognition in the Remote Context, successful recognition in the Proximal Context corresponded to late positive effects, similar to the Active old/new effects in either test context.

These results indicate that early negative effects in the Passive condition were context-specific, given that they were pronounced during recognition in the Remote Context, but not the Proximal Context. Conversely, late positive differences were apparent during recognition in the Proximal Context, whereas they were absent in the Remote Context. We hypothesize that these early negative old/new effects unique to Passive Recognition in the Remote Context reflected successful face-context binding, given that similar ERP effects were also identified for the Active Dm analysis when face-context binding was thought to occur.

3.2.4. Active versus Passive binding effects

Whereas binding between the faces and the Remote Context occurred during encoding in the Active condition, binding between the faces and the Remote Context occurred during Recognition in the Passive condition. Interestingly, ERPs corresponding to these hypothesized instances of across- and within-episode binding were remarkably similar in timing, directionality, and topography (Fig. 6). Both binding-related effects occurred at similar latencies; between 150 and 400 ms during encoding in the Active condition and between 150 and 400 ms during Recognition in the Passive condition. Furthermore, the directionality of both binding effects was negative, which is unusual given that both subsequent memory and Recognition memory effects typically involve enhanced positivity (Yovel & Paller, 2004; Rugg & Curran, 2007). Finally, both were frontocentrally distributed. Given these similarities, we aimed to determine if the amplitudes and spatial topographies of these two binding-related ERP effects statistically differed. (Data from 15 subjects were included in this comparison, such that all included subjects contributed data for both conditions; see Section 2.)

First, we determined if mean amplitudes corresponding to binding in the Active and Passive conditions differed by comparing the difference waves corresponding to the Active Dm effect and the Passive old/new effect in the Remote Context. A repeated measures ANOVA with binding condition (Active Refresh, Passive Recognition) and region (frontal, central, parietal, left lateral, right lateral) as factors did not reveal any significant effects ($Fs<.74$). Thus, the negative amplitudes corresponding to binding during Active Refresh and Passive Recognition did not

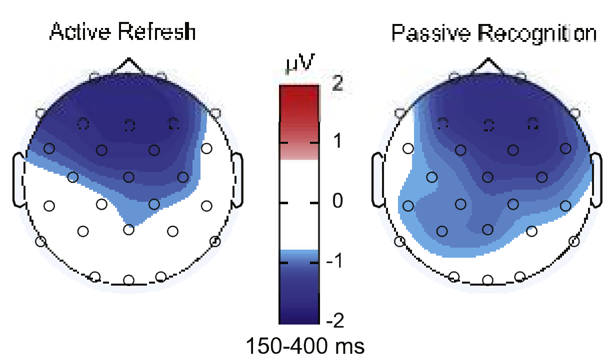

Fig. 6. Binding-related spatial topography. (A) Mean amplitude differences between 150 and 400 ms corresponding to the Active Dm effect (during encoding). (B) Mean amplitude differences between 150 and 400 ms corresponding to the Passive old/new effect in the Remote Context (during Recognition). Spatial topographies looked remarkably similar across the two contrasts, supporting the notion that early negative differences reflect face-context binding.

statistically differ. Next, we compared spatial topographies of these two binding-related effects to determine if the spatial distribution of the negative ERP effects differed across conditions. For this comparison, we normalized the difference waves corresponding to the Dm effect in the Active condition and the old/new effect in the Remote Context for the Passive condition according to the procedure recommended by McCarthy and Wood (1985). A repeated measures ANOVA with binding condition (Active Refresh, Passive Recognition) and location (30 scalp electrodes) as factors did not reveal a significant interaction [$F(3.98,55.78)=.70$, *ns*], indicating that the spatial topographies did not differ across Refresh conditions.

To further interrogate potential topographical differences for these two binding effects, we performed an additional analysis using data collapsed for the five electrode regions tested in the amplitude analysis. We averaged the difference amplitudes across electrodes for each of the 5 regional sites and then normalized the amplitudes across conditions (McCarthy & Wood, 1985). Normalized values were submitted to a repeated-measures ANOVA with region and binding condition (Active Refresh, Passive Recognition) as factors. The interaction of region and binding condition was not significant [$F(2.26,31.61)=.10$, *ns*]. Therefore, even after limiting the topographical analysis to the electrode sites used for the analyses of amplitude effects, we did not observe significant differences in the spatial distributions of the binding-related ERP effects.

These results are surprising, given that these ERP effects corresponded to different portions of the experiment, with distinct visual stimuli, and while subjects were engaged in different tasks. Although it is difficult to interpret lack of statistically significant differences, these results are consistent with the hypothesis that binding between the faces and the Remote Context occurred during Active Refresh, whereas binding between the faces and the Remote Context occurred during Passive Recognition. It is important to note, however, that the Active Dm effect appeared to be more frontocentrally located (indicated by an interaction of Region with face accuracy in the amplitude analysis), whereas the Passive Recognition effect was more broadly dispersed across the scalp (indicated by a main effect of face condition in the amplitude analysis). Despite these apparent spatial differences, the topographies did not statistically differ. In any case, the ERP correlates of binding across these two conditions were highly similar and atypical for ERP Dm and old/new effects during recognition memory with faces. Taken together, early negative differences corresponding to face-context memory may be a novel ERP index of binding.

4. Discussion

Active retrieval immediately prior to learning promoted across-episode binding during face encoding. In contrast, in the Passive condition (when active retrieval did not precede new learning), within-episode binding occurred later during Recognition, when information was physically paired. These across- and within-episode binding effects were marked by similar early negative ERPs that were strongly distinct from ERP correlates of encoding and retrieval (as identified here and in previous ERP memory studies). In the Active condition, early negative ERPs corresponded to across-episode binding during successful face encoding (predictive of subsequent face memory), whereas similar early negative ERPs corresponded to within-episode binding in the Passive condition during successful face recognition in the Remote Context. These behavioral and ERP findings are consistent with the hypothesis that active retrieval facilitated reactivation of the original memory content, thereby causing across-episode binding with the subsequently presented face. In contrast, because original memory content was not reliably activated in the Passive condition, binding did not occur until the faces were physically paired with the contextual information from the original episode during the Recognition test (within-episode binding). These findings provide a novel neural marker of episodic memory binding, and show that active retrieval modulates the contents of memory that are currently active and available for binding. These results build on our previous work (Bridge & Voss, 2014), further supporting the notion that memory traces that are currently active in memory are preferentially bound with relatively novel information.

We hypothesize that the early negative ERP effects observed during Active encoding and Passive Recognition in the Remote Context specifically reflected binding currently active memory traces and associatively novel information. These binding effects may be distinct from effects of binding new pieces of information encountered together in a similar spatiotemporal context. For instance, studies have indicated that information encountered within the same temporal context is bound during encoding (Sederberg et al., 2010). It is thus plausible that typical late positive Dm ERP effects (Paller & Wagner, 2002; Voss & Paller, 2008) correspond not only to subsequent memory of the current item but also to memory of the items encoded in the surrounding temporal context. Indeed, we observed late positive Dm effects in the Passive condition, which likely corresponded to binding between the faces and the proximal context information (the Proximal Context). Future studies should investigate if ERPs during item encoding correspond not only to subsequent memory of the current item, but also to items encoded in the surrounding temporal context to determine if late positive ERPs during encoding reflect memory of rich temporal context information in addition to item-specific information. In any case, the unique early negative Dm effect that we identified was very distinct from standard Dm effects, suggesting that binding of existing memory content with novel information is likely a distinct process from binding that occurs in standard recognition memory paradigms which involve only novel information.

Based on the Refresh phase alone, one could conclude that the negative-going ERPs in the Active condition reflected the amount of information being bound rather than across-episode binding per se, as two contexts were bound to the faces during Active Refresh but only one was bound to faces during Passive Refresh. However, during the Recognition phase, we observed these negative-going ERPs for Passive Recognition in the Remote Context, when the faces were bound to only one context scene. If these negative-going ERPs reflect the amount of information being bound, then the Passive Dm ERPs should be identical to the Passive Recognition old/new ERPs in the Remote Context, because in both cases the faces are being bound to only one scene (i.e. the amount of information being bound is the same). Instead, the negative-going ERPs are only observed for the Active Refresh Dm effect and the Passive Recognition old/new effect for the Remote Context; therefore, we infer that these early negative ERPs reflect binding between currently active memory information and associatively novel information (across- and within-episode binding), and that they are unrelated to the amount of information being bound (as this differed for the two effects).

Several studies have suggested that memory reactivation promotes integration of new information into related memory traces during learning (Shohamy & Wagner, 2008; Zeithamova & Preston, 2010; Zeithamova, Dominick, & Preston, 2012). In these studies, subjects learned pairs of items (e.g. A, B) and then learned overlapping pairs, in which old items were paired with new items (e.g. B, C). In a final generalization test, subjects judged the relatedness of the overlapping elements (i.e. A–C). These transitive associations could be learned either through a reactivation mechanism during learning or through an inference mechanism during testing. Using fMRI, Shohamy and Wagner (2008) found that hippocampal activity during B and C learning predicted subsequent generalization performance. In contrast, hippocampal activity during testing did not correspond to successful generalization performance, suggesting that reactivation of related information during learning promoted integration of new information into existing memory representations. Interestingly, only subjects with "good" generalization performance showed this enhanced hippocampal learning effect. It is possible that "good" learners engaged in more effortful retrieval processing during B and C learning to promote generalization performance on the test. This idea is consistent with the results from the present study, in that the active engagement of retrieval promoted across-episode binding during learning, whereas a passive reactivation task only supported within-episode binding when the stimuli were physically paired during the Recognition test.

It is possible that the current processing mode or state influences encoding and retrieval processes. Because the hippocampal system handles both encoding and retrieval functions, different types of input (e.g. old or new stimuli) could prime the system to perform either pattern separation (encoding) or pattern completion (retrieval). This idea was supported by a recent study, which demonstrated that identification of new stimuli promoted item discrimination (pattern separation), whereas identification of old stimuli promoted integration of familiar information into existing memory representations (pattern completion) (Duncan, Sadanand, & Davachi, 2012). In the current study, it could be argued that across-episode binding was promoted during Active retrieval merely because the hippocampal system was "primed" for pattern completion. However, this interpretation is difficult to reconcile with the ERP findings, because similar ERP effects both predicted subsequent face memory during encoding in the Active condition (across-episode binding) and corresponded to successful face memory during Recognition in the Remote Context in the Passive condition (within-episode binding). If ERPs during face encoding in the Active condition simply reflected a boost in retrieval-related processing, then we would expect to see early negative old/new effects for all conditions during Recognition. Instead, we observed early negative ERP effects selectively during Recognition in the Remote Context for the Passive condition. These conditions associated with similar ERP correlates of binding varied in terms of the type of stimuli and the encoding/retrieval demands, which is difficult to reconcile with the mode/state interpretation of the present effects. A more parsimonious explanation of these findings is that early negative ERPs reflected binding, and the engagement of active retrieval prior to learning systematically increased this binding.

The current findings lend further support to the idea that engaging in active learning or retrieval processes can have powerful effects on subsequent memory (Bridge & Paller, 2012). For instance, exerting volitional control during object-location learning facilitates later memory of the individual objects and the related spatial locations relative to passively viewing the objects in a predetermined sequence (Voss, Galvan, & Gonsalves, 2011; Voss, Gonsalves, Federmeier, Tranel, & Cohen, 2011; Voss et al., 2011). Taken together, these findings suggest that methods to promote active retrieval could be used to enhance encoding of novel information. By promoting retrieval of information from memory, new information may be encoded more efficiently and effectively. It is unclear from the current results what brain regions are involved in this binding-related facilitation by active retrieval, although our previous experiment specifically implicated anterior hippocampus (Bridge & Voss, 2014). By further refining knowledge of critical brain regions in future studies, it will be possible to determine whether facilitation by active retrieval would be appropriate for use by individuals suffering from memory impairments due to damage to regions likely involved, such as hippocampus and prefrontal cortex (which are prominently involved in the influence of active retrieval and learning on memory; Voss, Gonsalves et al., 2011; Voss, Warren et al., 2011; Bridge & Voss, 2014). In summary, active retrieval has a unique promotional effect on integrating new information into existing memories, over and above passively encountering familiar information. The current behavioral and ERP findings indicate this is because active retrieval allows binding to occur for specific memory content, and that the binding process could be quite similar for this across-episode binding relative to within-episode binding of co-occurring information.

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APPENDIX C

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Northwestern Now (//)

How Your Memory Rewrites the Past

Your memory is no video camera; it edits the past with present experiences

February 04, 2014 | By Marla Paul (//for-journalists/staff-page/show/marla-paul)

CHICAGO --- Your memory is a wily time traveler, plucking fragments of the present and inserting them into the past, reports a new Northwestern Medicine® study. In terms of accuracy, it's no video camera.

Rather, the memory rewrites the past with current information, updating your recollections with new experiences.

Love at first sight, for example, is more likely a trick of your memory than a Hollywood-worthy moment.

"When you think back to when you met your current partner, you may recall this feeling of love and euphoria," said lead author Donna Jo Bridge, a postdoctoral fellow in medical social sciences at Northwestern University Feinberg School of Medicine. "But you may be projecting your current feelings back to the original encounter with this person."

The study is published Feb. 5 in the Journal of Neuroscience.

This the first study to show specifically how memory is faulty, and how it can insert things from the present into memories of the past when those memories are retrieved. The study shows the exact point in time when that incorrectly recalled information gets implanted into an existing memory.

To help us survive, Bridge said, our memories adapt to an ever-changing environment and help us deal with what's important now.

"Our memory is not like a video camera," Bridge said. "Your memory reframes and edits events to create a story to fit your current world. It's built to be current."

All that editing happens in the hippocampus, the new study found. The hippocampus, in this function, is the memory's equivalent of a film editor and special effects team.

For the experiment, 17 men and women studied 168 object locations on a computer screen with varied backgrounds such as an underwater ocean scene or an aerial view of Midwest farmland. Next, researchers asked participants to try to place the object in the original location but on a new background screen. Participants would always place the objects in an incorrect location.

For the final part of the study, participants were shown the object in three locations on the original screen and asked to choose the correct location. Their choices were: the location they originally saw the object, the location they placed it in part 2 or a brand new location.

“People always chose the location they picked in part 2,” Bridge said. “This shows their original memory of the location has changed to reflect the location they recalled on the new background screen. Their memory has updated the information by inserting the new information into the old memory.”

Participants took the test in an MRI scanner so scientists could observe their brain activity. Scientists also tracked participants’ eye movements, which sometimes were more revealing about the content of their memories – and if there was conflict in their choices -- than the actual location they ended up choosing.

The notion of a perfect memory is a myth, said Joel Voss, senior author of the paper and an assistant professor of medical social sciences and of neurology at Feinberg.

“Everyone likes to think of memory as this thing that lets us vividly remember our childhoods or what we did last week,” Voss said. “But memory is designed to help us make good decisions in the moment and, therefore, memory has to stay up-to-date. The information that is relevant right now can overwrite what was there to begin with.”

Bridge noted the study’s implications for eyewitness court testimony. “Our memory is built to change, not regurgitate facts, so we are not very reliable witnesses,” she said.

A caveat of the research is that it was done in a controlled experimental setting and shows how memories changed within the experiment. “Although this occurred in a laboratory setting, it’s reasonable to think the memory behaves like this in the real world,” Bridge said.

The research was supported by the National Institute of Neurological Disorders and Stroke grant R00-NS069788 and the National Institute on Aging grant T32AG20506, both of the National Institutes of Health.

Topics: Brain (//topics/show/brain) , Chicago (//topics/show/chicago) , Feinberg School of Medicine (//topics/show/feinberg-school-of-medicine) , Grants (//topics/show/grants) , Medicine (//topics/show/medicine) , Northwestern Medicine (//topics/show/northwestern-medicine) , Research (//topics/show/research) , Video (//topics/show/video)

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APPENDIX D

The New York Times | https://nyti.ms/2GE3piY

‘Testilying’ by Police: A Stubborn Problem

Police lying persists, even amid an explosion of video evidence that has allowed the public to test officers’ credibility.

By JOSEPH GOLDSTEIN MARCH 18, 2018

Officer Nector Martinez took the witness stand in a Bronx courtroom on Oct. 10, 2017, and swore to tell the truth, the whole truth, and nothing but the truth, so help him God.

There had been a shooting, Officer Martinez testified, and he wanted to search a nearby apartment for evidence. A woman stood in the doorway, carrying a laundry bag. Officer Martinez said she set the bag down “in the middle of the doorway” — directly in his path. “I picked it up to move it out of the way so we could get in.”

The laundry bag felt heavy. When he put it down, he said, he heard a “clunk, a thud.”

What might be inside?

Officer Martinez tapped the bag with his foot and felt something hard, he testified. He opened the bag, leading to the discovery of a Ruger 9-millimeter handgun and the arrest of the woman.

But a hallway surveillance camera captured the true story: There’s no laundry bag or gun in sight as Officer Martinez and other investigators question the woman in the doorway and then stride into the apartment. Inside, they did find a gun, but little to link it to the woman, Kimberly Thomas. Still, had the camera not captured the hallway scene, Officer Martinez’s testimony might well have sent her to prison.

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When Ms. Thomas's lawyer sought to play the video in court, prosecutors in the Bronx dropped the case. Then the court sealed the case file, hiding from view a problem so old and persistent that the criminal justice system sometimes responds with little more than a shrug: false testimony by the police.

"Behind closed doors, we call it testilying," a New York City police officer, Pedro Serrano, said in a recent interview, echoing a word that officers coined at least 25 years ago. "You take the truth and stretch it out a little bit."

An investigation by The New York Times has found that on more than 25 occasions since January 2015, judges or prosecutors determined that a key aspect of a New York City police officer's testimony was probably untrue. The Times identified these cases — many of which are sealed — through interviews with lawyers, police officers and current and former judges.

[**ALSO READ**: He Excelled as a Detective, Until Prosecutors Stopped Believing Him]

In these cases, officers have lied about the whereabouts of guns, putting them in suspects' hands or waistbands when they were actually hidden out of sight. They have barged into apartments and conducted searches, only to testify otherwise later. Under oath, they have given firsthand accounts of crimes or arrests that they did not in fact witness. They have falsely claimed to have watched drug deals happen, only to later recant or be shown to have lied.

No detail, seemingly, is too minor to embellish. "Clenched fists" is how one Brooklyn officer described the hands of a man he claimed had angrily approached him and started screaming and yelling — an encounter that prosecutors later determined never occurred. Another officer, during a Bronx trial, accused a driver of recklessly crossing the double-yellow line — on a stretch of road that had no double-yellow line.

In many instances, the motive for lying was readily apparent: to skirt constitutional restrictions against unreasonable searches and stops. In other cases, the falsehoods appear aimed at convicting people — who may or may not have committed a crime — with trumped-up evidence.

In still others, the motive is not easy to discern. In October 2016, for example, a plainclothes Brooklyn officer gave a grand jury a first-person account of a gun arrest. Putting herself in the center of the action, the officer, Dornezia Agard, testified that as she approached a man to confront him for littering, he suddenly crouched behind a van, pulled from his waistband a dark object — later identified as a gun — and threw it on the ground.

"P.O. Agard testified that she heard a hard metal object hit the ground," according to a letter the Brooklyn district attorney's office wrote summarizing her testimony.

But prosecutors lost faith in her account in July 2017, after learning from other officers that she was not among the first officers on the scene. Officer Agard had arrived later as backup, according to the letter, which noted that the gun charges against the man were later dismissed. The prosecutors did not address why Officer Agard claimed to be a witness, or why the other officers present seem to have allowed her to process the arrest.

Police lying raises the likelihood that the innocent end up in jail — and that as juries and judges come to regard the police as less credible, or as cases are dismissed when the lies are discovered, the guilty will go free. Police falsehoods also impede judges' efforts to enforce constitutional limits on police searches and seizures.

"We have 36,000 officers with law enforcement power, and there are a small handful of these cases every year," said J. Peter Donald, a spokesman for the Police Department, the nation's largest municipal force. "That doesn't make any of these cases any less troubling. Our goal is always, always zero. One is too many, but we have taken significant steps to combat this issue."

Shrouded, but Persistent

The 25 cases identified by The Times are almost certainly only a fraction of those in which officers have come under suspicion for lying in the past three years. That's because a vast majority of cases end in plea deals before an officer is ever required to take the witness stand in open court, meaning the possibility that an officer lied is seldom aired in public. And in the rare cases when an officer does testify in court — and a judge finds the testimony suspicious, leading to the dismissal of the case — the proceedings are often sealed afterward.

Still, the cases identified by The Times reveal an entrenched perjury problem several decades in the making that shows little sign of fading.

So far in 2018, a Queens detective has been convicted of lying in a drug case and a Brooklyn detective has been arrested amid accusations that he fabricated the results of a photo lineup. These cases returned the phenomenon of police lying to the public eye, leaving police officials to defend the integrity of honest officers.

Kevin Richardson, the Police Department's top internal prosecutor, said he believed so-called testilying was nearing its end. "I think it's a problem that's very much largely on its way out," he said.

Indeed, it's tempting to think about police lying as a bygone of past eras: a form of misconduct that ran unchecked as soaring street violence left the police overwhelmed during the 1980s and early 1990s and that re-emerged as police embraced stop-and-frisk tactics and covered up constitutional violations with lies.

But false testimony by the police persists even as crime has drastically receded across the city and as the Police Department has renounced the excesses of the stop-and-frisk years.

Some policing experts anticipate that the ubiquity of cameras — whether on cellphones, affixed to buildings or worn by officers — will greatly reduce police lying. For the moment, however, video seems more capable of exposing lies than vanquishing them.

Memory and Manipulation

In two recent cases, The Times found, officers appear to have given false accounts about witness identifications. These cases are particularly troubling because erroneous identifications by witnesses have been a leading cause of wrongful convictions.

After a 2016 mugging near a Brooklyn subway station, the police arrested a group of four people, one of whom was found to be in possession of the victim's wallet. In preparing the case, prosecutors sought to pin down a few basic facts. Had the police brought the victim, who was punched and had his wallet taken, to positively identify the four suspects after they were taken into custody? If so, what had the victim said?

Getting a straight answer from the arresting officer, Chedanan Naurang, proved nearly impossible. It had been Officer Naurang's quick thinking that had made the arrest possible: Having lost the suspects at one subway station, he followed a hunch and drove one stop down the line, where he caught up with the four men after they got off the train.

But certain details Officer Naurang gave prosecutors kept shifting over the next year, according to a February 2017 letter that prosecutors wrote in which they summarized his fluid story.

Officer Naurang said at one point that the identification had occurred inside a police station when the victim passed by the holding cells, saw the men and confirmed their involvement in the crime.

[**ALSO READ**: Two NYPD Officers Are Charged With Lying About Suspect]

A few weeks later, he backtracked. No, the victim had actually never gotten to see the suspects at the police station, Officer Naurang explained. Instead, the victim had gotten a chance to view them on the street, shortly after their arrest. That's when the victim got out of the police vehicle in which he had been waiting, Officer Naurang said, and pointed to one of the four men, identifying him as an attacker.

This version of events, however, was at odds with the recollection of the police officer who had driven the victim to the scene of the arrest. That officer, Christopher McDonald, told prosecutors that the victim had remained in the back seat while viewing the four suspects. And Officer McDonald said that the victim couldn't say whether they were his assailants. He thought he recognized their clothing, but wasn't sure.

Because of Officer Naurang's changing story, prosecutors dropped the case against the men as part of a deal in which all four pleaded guilty to charges stemming from a second mugging they were accused of the same night.

Another case in which the police gave false information about a witness identification came after a carjacking in Brooklyn in 2015. In that case, the police began to focus on two suspects based on an anonymous tip and a fingerprint. A detective, Michael Foder, testified that he had then prepared two photo lineups — one for each suspect.

Each consisted of the suspect's photograph printed on a sheet of paper, alongside the photos of "fillers" — people of vaguely similar appearance with no connection to the crime. The hope was that the victim, a livery cabdriver, might recognize the suspect's photo and pick him out — an outcome that prosecutors regard as a strong indicator of a suspect's guilt.

That's what happened, Detective Foder testified, when the victim came to the precinct to view the photo lineup for one suspect in November 2015 and returned in February 2016 to view one for the second suspect.

But the photo lineups that Detective Foder had prepared — and were submitted as evidence in federal court — were fabrications. It was a federal prosecutor who first realized that many of the photos used in the lineups were not yet available at the time Detective Foder claimed to have shown them to the victim. The reason? The photos of some of the fillers had yet to be taken.

The lineup that was said to be from November 2015 included filler photographs that were not taken until December. And the one he claimed to have administered in February featured photos that were taken in March.

Last month, Detective Foder was indicted on federal perjury charges. The indictment accuses him of lying to "conceal the fact that he had falsified documentation" related to the photo lineups. Detective Foder's lawyer entered a plea of not guilty on the detective's behalf.

Justifying a Search

Detective Foder's actions appear to be aimed at tilting the scales toward guilt.

But more often, The Times found, false statements by the police seem intended to hide illegal searches and seizures, such as questionable car stops or entries into apartments that result in officers finding guns or drugs. If the truth were to emerge that the case began with an illegal police search, the evidence would quite likely be thrown out and the case dismissed.

The story that Christopher Thomas, a plainclothes police officer, told a grand jury in December 2014 sounded plausible enough. As he approached a parked car with a flashlight in hand, he said, he saw a man in the driver's seat pull a firearm out of his waistband and stick it between the car's center console and the front seat. The driver was indicted on gun-possession charges.

But by July 2015, as video of the encounter was about to emerge, Officer Thomas started backtracking. In conversations with the assistant district attorney on the case, Officer Thomas acknowledged that he had not seen the driver pull the gun from his waistband. In fact, he said, he had never seen the driver with his hand on the gun.

"He stated to the A.D.A. that he did not know why he had testified to those facts before the grand jury," according to an email prosecutors later sent to a defense lawyer. This email, as well as several similar letters that prosecutors sent in other cases, were provided to The Times by Cynthia Conti-Cook, a Legal Aid Society lawyer who has been compiling a database of police misconduct allegations.

The video undermined Officer Thomas's original claim of having seen the gun at the outset. It shows Officer Thomas and his partner approach the car and shine their flashlights inside. Their demeanor on the video suggests that they had seen nothing so far to cause alarm. One of the two officers — either Officer Thomas or his partner — is so unconcerned that he bends down for about seven seconds, and appears to tie his shoe.

Brooklyn prosecutors dismissed the gun case and, according to the prosecutors' email, informed the Police Department's Internal Affairs Bureau about the problems with Officer Thomas's account. An internal police disciplinary process led to Officer

Thomas losing 30 vacation days and being placed on dismissal probation for a year, according to a person familiar with the case.

He is now a sergeant in a narcotics unit.

Officer Thomas is not the only officer to have tried to withdraw earlier testimony as soon as video of an encounter emerged, or was about to.

"I misspoke when I was in grand jury," Sean Kinane, an officer with the 52nd Precinct in the Bronx, testified in federal court in 2016. That was all the explanation he gave, or was asked to give, for why he was recanting his earlier testimony about witnessing what appeared to be narcotics transactions in the moments before he stopped a heroin dealer in the street.

That claim, if true, would have given the police justification to stop the man, who was discovered to be carrying 153 glassine envelopes of heroin and eight bags of crack cocaine. But after the drug dealer managed to get a video recording of the encounter, Officer Kinane's story changed. He had misspoken.

Reached by telephone for comment, Detective Kinane — he was promoted in 2017 — hung up.

'No Fear of Being Caught'

Many police officials and experts express optimism that the prevalence of cameras will reduce police lying. As officers begin to accept that digital evidence of an encounter will emerge, lying will be perceived as too risky — or so the thinking goes.

"Basically it's harder for a cop to lie today," the Police Department's top legal official, Lawrence Byrne, said last year at a New York City Bar Association event, noting that there were millions of cellphones on the streets of New York, each with a camera. "There is virtually no enforcement encounter where there isn't immediate video of what the officers are doing."

As more police encounters are recorded — whether on the cellphones of bystanders or the body-worn cameras of officers — false police testimony is being exposed in cases where the officer's word might once have carried the day. That is true for run-of-the-mill drug cases as well as for police shootings so notorious that they are seared into the national consciousness.

Yet interviews with officers suggest the prevalence of cameras alone won't end police lying. That's because even with cameras present, some officers still figure — with good reason — that a lie is unlikely to be exposed. Because plea deals are a typical outcome, it's rare for a case to develop to the point where the defendant can question an officer's version of events at a hearing.

[**ALSO READ**: New York Detective Charged With Faking Lineup Results]

"There's no fear of being caught," said one Brooklyn officer who has been on the force for roughly a decade. "You're not going to go to trial and nobody is going to be cross-examined."

The percentage of cases that progress to the point where an officer is cross-examined is tiny. In 2016, for instance, there were slightly more than 185 guilty pleas, dismissals or other non-trial outcomes for each criminal case in New York City that went to trial and reached a verdict. There were 1,460 trial verdicts in criminal cases that year, while 270,304 criminal cases were resolved without a trial.

To be sure, officers are sometimes called to testify before trial at so-called suppression hearings in which the legality of police conduct is evaluated. But those are rare. In Manhattan, about 2.4 percent of felony criminal cases have a suppression hearing, according to data from the Manhattan district attorney's office. The rate for non-felony cases is slightly more than one-tenth of 1 percent.

A Crucial Court Decision

Several officers, all working in the Bronx and Brooklyn, candidly described in interviews how the practice of lying runs like a fault line through precincts. "You're either a 'lie guy' or you're not," said the Brooklyn officer. Speaking on condition of anonymity, he described how he avoided certain officers and units in his precinct based on his discomfort with the arrests they made.

Earlier in his career, he said, a supervisor and a detective had each encouraged him to lie about the circumstances of drug arrests. Another time, he said, he had worked with an officer who, after discovering drugs while searching a suspect without cause, turned to the other officers present with a question — "How did we find this?" — and sought their help devising a false story.

Countless police officers have struggled with that question — "How did we find this?" — ever since 1961, when the Supreme Court ruled, in Mapp v. Ohio, that state judges must throw out evidence from illegal searches and seizures. Before this ruling, New York City officers could stop someone they thought might be dealing or using drugs, search their pockets and clothing, describe the encounter truthfully, and not worry that a court would throw out the drugs that they had discovered, even though the stop and search had been, strictly speaking, illegal. That changed with the Mapp decision, which greatly expanded the reach of the Fourth Amendment.

Immediately after the Mapp case, police officers saw many narcotics cases be dismissed. Then they made what one judge called "the great discovery." If they testified that the suspect had dropped a bag of drugs on the ground as the police approached, courts would generally deem those arrests legal.

Within a year of the Mapp decision, courts in New York City were seeing a marked increase in what became known as "dropsy" testimony — in some units "dropsy" cases increased more than 70 percent, according to one 1968 study.

There was little reason to think drug users had grown more skittish. Rather, the influx of these cases was understood to be a sign that police officers were lying in a substantial number of cases. Ever since, courts in New York have been plagued with officers lying about how they came to discover that a suspect was carrying drugs or guns.

By 1994, a commission appointed to investigate police corruption noted that lying to make cases stick was common enough for "testilying" to become a well-known portmanteau.

The report by the Mollen Commission noted a few established patterns of falsehoods. Officers who illegally searched a car might later say they discovered contraband in "plain view." Or an officer who found a gun or drugs in someone's clothing during an illegal search might falsely claim to have seen "a bulge in the person's pocket."

Just like the dropsy testimony a few decades earlier, these stories of "plain view" and "suspicious bulges" became scripts that many police officers stuck to. They were rarely challenged, not even as officers in New York City began repeating them tens and then hundreds of thousands of times as police stops of mainly black and Latino men skyrocketed during the years Michael R. Bloomberg was mayor.

Embellished Narratives

In recent years, the number of times police stopped and frisked pedestrians has declined precipitously. But certain plainclothes units, such as the so-called anti-crime teams, still engage in an aggressive style of policing that relies heavily on stop-and-frisk tactics. These teams make a disproportionate number of gun arrests, but they are also responsible for a substantial number of dubious stops of pedestrians and drivers, police officers and legal experts said in interviews.

Several uniformed patrol officers said they have long suspected that the track record of plainclothes anti-crime teams for making weapons and drug arrests was bolstered by illegal searches and a tolerance for lying about them.

These officers described a familiar scene: a group of black men ordered out of a vehicle for little reason and made to sit on the curb or lean against the bumper, as officers search the vehicle for guns and drugs.

"Certain car stops, certain cops will say there is odor of marijuana. And when I get to the scene, I immediately don't smell anything," said Officer Serrano, one of the few officers interviewed who was willing to speak on the record. "I can't tell you what you smelled, but it's obvious to me there is no smell of marijuana."

Mr. Serrano's testimony about a secret station-house recording he made was crucial evidence in a landmark stop-and-frisk trial in 2013. He and nearly a dozen other current and former officers are suing the Police Department over what they describe as arrest quotas.

"It's the anti-crime teams, the plainclothes officers, everyone knows they will violate the law, get what they want and then write it to fit the narrative," said Edwin Raymond, a police sergeant who is also a plaintiff in the arrest-quota case. "The narratives will be embellished to fit the parameters of probable cause, if need be."

'A Surreal Journey'

To be sure, there are other motives for lying, other than to cover up illegal searches.

Some police officers have said they faced pressure from commanders to write more tickets or make more arrests. A decade ago, narcotics detectives were found to have falsely accused people of dealing drugs in order to meet arrest quotas.

And there is pressure to solve — or at least close — cases. That may have motivated Officer Martinez's gun-in-the-laundry-bag-in-the-doorway story.

What appears to have actually happened is that Officer Martinez and other officers searched inside the apartment for evidence from a nearby shooting. They had good reason to focus on that apartment. The victim, after being shot, had rushed there, along with others. Crime-scene photos taken by the department's Evidence Collection Team suggest that a gun was found inside the apartment, in or near a laundry bag on the floor.

But whose gun was it? That was not clear. A number of people had been in the apartment in the preceding hours. And Ms. Thomas, who lived more than a mile away and arrived about an hour after the shooting, was one of the few people there when Officer Martinez showed up.

There is little, if any, evidence tying Ms. Thomas to the gun other than Officer Martinez's false testimony that placed her in the doorway with the laundry bag in her arms. Prosecutors acknowledged that DNA testing indicates that Ms. Thomas did not handle the gun. Moreover, court papers that prosecutors filed after the case fell apart noted that the police appear to have focused on Ms. Thomas while ignoring other potential suspects. Several other people had entered the apartment shortly before Ms. Thomas — "none of whom are questioned by the police," the prosecutors' papers noted.

As for Officer Martinez's false story of the laundry bag in the doorway, the prosecution's legal papers noted only that "there are clear inconsistencies" between Officer Martinez's "recollection of events and the video."

"At no time in this video is there a laundry bag in the defendant's hands," the prosecution's legal papers noted. "Neither is there a bag in the doorway of the apartment, and at no time is the arresting officer observed moving a bag before entering the apartment."

By the time prosecutors officially dropped the case in November 2017, Ms. Thomas had already appeared in court 16 times, according to a tally of appearances kept by one of her lawyers, Alexandra Conlon, of the Bronx Defenders. On the last appearance, Ms. Thomas, 39, asked to address the court. "For 396 days I have been fighting for my life, my freedom and my sanity," she said. "This has been such a surreal journey that I don't wish on anyone."

Officer Martinez remains in good standing at the 41st Precinct. Shortly after the case was dismissed, he was promoted to detective and given his gold shield. When a reporter tried to interview him in January about his testimony in the case, he declined to comment, saying, "That's not something I can speak about directly with you."

Nate Schweber contributed reporting. Susan Beachy, Doris Burke and Jack Begg contributed research.

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